Chapter 3: Refuge and Resources Description

History and Establishment of Mark Twain NWR [12]

Mark Twain Refuge, and consequently the individual refuges within it as a Complex, shares much of its history with the Upper Mississippi River National Wildlife and Fish Refuge, the U.S. Army Corps of Engineers, and the five states of the UMRS. The Refuge was officially established in 1958, but the Department of the Interior had been involved on the Upper Mississippi River for many years regarding navigation, protection of wildlife, and public recreation. At all times in the nation's history, including the present, the dominant objective of the Federal government in the Mississippi River was the use of the River for navigation. Even though wildlife and habitat concerns were expressed early in the 20th century, these "environmental" objectives have remained secondary to the economic benefits associated with the navigation system. The current day Refuge is obliged to plan and operate within the context of this history, along with the physical and legal constraints attendant with managing a subordinate River objective. This section of the CCP is more extensive than that for most refuges, however the history of the Mark Twain NWR Complex has many twists and turns that continue to have a bearing on the daily operations of each refuge within the Complex.

Mark Twain NWR Complex File Photo

Pre-Refuge History

As early as 1882, unpatented islands in the Mississippi River below Cairo, Illinois were withdrawn by the Secretary of the Interior at the request of the Secretary of War to serve the interests of navigation. The COE had been authorized to maintain channels of varying depths since the 1880s. The COE believed that by withdrawing islands from disposal by the Federal government, the islands would be used by all navigating on the River, or could be removed as necessary to maintain a navigable channel. In 1891, a similar request was made for the removal of islands in the Mississippi above Cairo. The islands were temporarily withdrawn by the Secretary of the Interior on April 10, 1891. Withdrawal protected the islands from private ownership and maintained them in a relatively

[12] Most of the material for this section came from files at the Refuge Complex Office and an unpublished document prepared by Michael Fairchild, May 1982, titled "The Legal and Administrative History of the Upper Mississippi River Wildlife and Fish Refuge." The research and resulting report completed by Mr. Fairchild fulfilled a contract service to the FWS during the UMRNW&FR Master Plan process, which was completed in 1987.

undisturbed state. These islands were among the first lands to be included in the Upper Mississippi River Wildlife and Fish Refuge. On June 7, 1924, Congress passed legislation creating the Refuge. Shortly thereafter, the Secretary of War notified the Secretary of the Interior that the islands were no longer needed by the War Department and, on April 25, 1925, the 1891 withdrawal order was revoked. Authority over the islands, no longer withdrawn, and other vacant public lands was transferred to the Department of Agriculture for inclusion in the Refuge as a result of Executive Order 4519 of October 2, 1925.

As early as 1900, conservationists were trying to maintain and restore wildlife of the River and urged the Bureau of Fisheries of the Department of Commerce and Labor to begin fish rescue operations along the UMR. This effort was expanded to include the propagation of freshwater mussels in 1908, when Congress provided funding for the establishment of a biological station in the "Mississippi Valley." The UMR and its floodplain flats had been a particularly fertile habitat for numerous freshwater fish, mussels, fur-bearing animals and migratory birds. These same lands and waters were considered wastelands for agriculture, homesteading and industrial development. The dominant uses of the area were sport and commercial fishing, mussel harvesting for the pearl and button industry, hunting and furbearer trapping. But by the 1920s, the UMR was being threatened by over-hunting, pollution and drainage of the surrounding wetlands.

Within a few years of the Upper Mississippi River National Wildlife and Fish Refuge's creation, the Corps of Engineers became highly involved in the process of developing a 9-foot channel in the Mississippi River upstream from the confluence of the Missouri River. After construction and when operational, the 9-Foot Channel Project greatly increased commercial traffic and drastically altered the type of habitat in the River and Refuge. Most of the Upper Mississippi River National Wildlife and Fish Refuge lands were submerged by the navigation pools created by the locks and dams. The project changed nearly everything about the existing Refuge, and it created new opportunities south of the Refuge from Rock Island to the Missouri River where the Mark Twain Complex is now located.

Corps of Engineers Activity on the UMR

Army Corps of Engineers flood control and navigation improvement activities on the Upper Mississippi River had begun long before the Upper Mississippi River Refuge was established. In 1871, funds were appropriated by Congress for the COE to improve navigation on the Mississippi River above the confluence with the Ohio River. Most of the initial COE activity on the channel involved keeping the River clear of snags. On occasion, the COE was also authorized to conduct dredging operations. By 1878, the COE had begun work on maintaining a 4-foot channel to Minneapolis. In 1910, Congress authorized the COE to pursue a 6-foot channel project above the confluence of the Missouri River. The demand for greater shipping use of the River created the demand for a deeper channel through to the Minneapolis grain elevators. Congress approved the 9-Foot Project and between 1930 and 1940 26 locks and dams were constructed from Alton, Illinois to Minneapolis, Minnesota.

Both the Bureau of Biological Survey (BBS), which later became the FWS, and the COE recognized the damage to wildlife that was resulting from the first locks and dams installed at Hastings, Minnesota, and Keokuk, Iowa. The pools that formed behind the dams slowed flowage and decreased the oxygen level in the water. Silt on the riverbed killed some aquatic animals, such as mussels and food sources for fish. In addition, because the locks and dams were unequipped to facilitate fish movement, a dozen species of migratory fish were affected by the 9-Foot Channel Project. Consequently, both commercial fishing and mussel harvesting were dramatically decreased. On the other hand, both agencies also recognized that new aquatic habitats were created and that in spite of the above problems, it would be many years until those values would be overtaken by those problems. One solution considered by the BBS and COE to address the conflicting Congressional directives was for the COE to purchase the lands to be flooded in fee and transfer those lands unnecessary for managing the navigation project to the Bureau. The BBS urged the COE to manage the pools in a manner that would stabilize the water level rather than managing mid-winter drawdowns in support of downstream navigation. (While "abnormal" water level spiking is still a concern, the Service is now working with the COE to accomplish early summer seasonal drawdowns – see Pool Level Management.)

Negotiations for early interagency agreements were necessitated by conflicts between Refuge and COE objectives resulting from different project purposes. Refuge staff wanted to reduce or eliminate secondary interests, such as agricultural leaseholds, cabin sites, or timber rights, which parties had on COE land. The COE, on the other hand, wished to have all the land it purchased readily available to serve the COEs' primary navigation purpose (as well as all support activities) and secondary purposes (economic uses and recreational), while avoiding the direct policing and maintenance of so much land. The Refuge viewed the land as wildlife habitat that needed protection from various uses, while the COE at that time viewed the land excess to its primary purpose as an investment from which an economic return could be derived.

USFWS File Photo

In 1931, the Secretary of Agriculture initiated negotiations with the Secretary of War to develop a working agreement between the two agencies, and an informal agreement was achieved. The first formal documentation of an agreement between the BBS and the COE is provided by three executive orders issued by President Roosevelt between September 1935 and October 1936. The executive orders were issued at the request of the Secretary of War and the Secretary of Agriculture. These executive orders differed only as to which lands were reserved to the Refuge. The orders reserved COE lands.... "for the use of the Department of Agriculture as a breeding place for migratory birds, other wild birds, game animals, fur-bearing animals, fish and other aquatic animal life and for the conservation of wild flowers and aquatic plants, to be administered as a part of the Upper Mississippi River Wild Life and Fish Refuge." The executive orders noted that the lands "are primarily under the jurisdiction of the War Department" and conditioned the reservations with the right of the COE to pursue its activities without interference. A 1940 executive order (No. 8331) reserved additional COE lands for Refuge use.

The 1945 Cooperative Agreement

By the 1940s, both the FWS and the COE recognized that a more structured arrangement between the agencies was necessary to facilitate the administration of COE owned lands within the Refuge. Coordination of the land transfers were facilitated by Executive Order Number 9146 (later addressed by E.O. 9337) that vested the authority to withdraw or reserve public lands in the Secretary of Interior, provided that concurrence for the withdrawal or reservation was obtained from the head of the agency or department having primary jurisdiction.

To help clarify their relationship to these federally owned lands, the COE and [FWS] began to plan for cooperative use in late 1941 by classifying the lands and preparing a written agreement. In 1942, the Secretary of the Interior suggested to the Secretary of War that all COE lands not used for navigation should be transferred to the Department of Interior for administration as part of the Upper Mississippi River National Wildlife and Fish Refuge. Interior Secretary Ickes pointed out that there had been an agreement to that effect since the early 1930s. Shortly thereafter, additional COE lands were reserved by the Interior Department as part of the Refuge. Negotiations were held from 1941 through 1945 between the FWS and the COE, without the participation of the states, which were successfully concluded with the signing of the first cooperative agreement on May 15, 1945.

The 1945 agreement categorized lands within the Upper Mississippi River National Wildlife and Fish Refuge, as well as new Refuge areas through the pooled project south of the Quad Cities[13], into red, brown, blue and uncolored areas. Red and brown areas were to be administered by the FWS. Hunting was prohibited on COE lands adjacent to “Brown lands” but not on lands adjacent to “Red lands.” “Blue lands” were administered by the FWS for hunting and trapping only. “Uncolored lands” were those that would be maintained and administered by the COE for project operations. The COE retained the right to administer timbering programs on all lands it had originally purchased. All lands originally purchased by the COE, whether transferred or not, were to remain under COE primary jurisdiction even if management of the lands had been transferred.

Not long after completion of negotiations for the first cooperative agreement, the FWS requested further control by the Refuge because the leasing authority retained by the COE continued to interfere with administration of the Refuge. Another concern was whether the COE could transfer lands directly to the states for administration, or whether the transfer had to be made through the FWS.

The 1954 Cooperative Agreement and General Plan

The first conference between the COE, FWS, and the states to negotiate general plans was held in St. Louis, Missouri, in 1950. The COE still resisted land transfers through any devices other than revocable permits. Related issues were direct land transfers to the states and the relative authority of the 1946 Fish and Wildlife Coordination Act Amendments and the 1946 Flood Control Act. Although these last two issues were related because the COE insisted that the 1946 Flood Control Act called for direct transfer of land (except those necessary for

[13] The reach of the river that included pools 15 through 26 was beyond the original Upper Miss Refuge project area. These additional FWS interests, as they developed with the COE and states, were managed out of the Upper Miss Winona office until the creation of the Mark Twain as a separate Refuge in 1958. The first Service employee in the new area was assigned to the Alton Pool (26) in the autumn of 1943.

the purposes of the Migratory Bird Treaty Act) to the states for water use projects, the issues were negotiated and resolved separately.

By late 1951 the Department of the Interior and Department of the Army reached an agreement to dispose of wildlife lands in accordance with the 1946 Coordination Act Amendments. Direct land transfers were resolved simply for Illinois, Missouri and Wisconsin because these states were satisfied with the system already in effect whereby land was first transferred through the FWS. Iowa was at first interested in direct transfers particularly to allow Iowa to develop the Lake Odessa area for hunting. After the FWS clarified to Iowa that the State would obtain control of the same lands under cooperative agreement with the FWS as it would from direct leases from the COE, Iowa dropped its interest for direct transfers. Minnesota also requested direct COE-to-State transfers for the land within the Pool 3 area. Minnesota later withdrew its request to facilitate a five state/FWS unity on negotiating with the COE over the general plans. As a result, by mid-1952, direct land transfers were no longer a topic of dispute. At the time the COE insisted on 25-year revocable permits for use by the Refuge. The FWS wanted transfer of complete jurisdiction over all lands, unencumbered by any COE leases or reservations. In late 1952, a compromise was reached which allowed for the transfer of land without time limitations and revocation only upon mutual consent by the COE and FWS or in the event of national emergency.

The General Plans all had been executed by the states and forwarded with the COE/FWS Cooperative Agreement to Washington, D.C. by April 1953. In October 1953, the Secretary of the Army approved the General Plans for all five states the General Plans had been completely executed and were signing by the Service and the COE by January 21, 1954. Additional step-down cooperative agreements were established between the states and the Service for state managed areas. The final action taken to place all transferred lands under the authority of the 1954 Cooperative Agreement was the revocation of all executive orders and public land orders that previously transferred COE lands to the Refuge. This was accomplished on February 19, 1954, by the publishing of Public Land Order 936. Henceforth, Service authority over COE land within the Refuge depended exclusively on the cooperative agreement.

The 1954 Cooperative Agreement and the 1953 General Plans provided a unified system of administration over COE lands. Only three major categories of land were to exist: "Green lands" were Upper Miss. Act land as part of the original Refuge; "Blue lands" were non-transferred COE land; and "Red lands" were those transferred by cooperative agreement. Some project lands were transferred from the Service to the states (Illinois, Iowa and Missouri) for administration.

Although the new agreements appeared to clarify the rights and responsibilities of the parties involved, the shortcomings of the cooperative agreement soon became apparent. The Refuge staff had believed that the FWS had exclusive jurisdiction over transferred lands, referred to as "Red lands." The cooperative agreement, however, made Nine-Foot Channel Project lands "available . . . for the conservation, maintenance, and management of wildlife, resources thereof, and its habitat thereon, in connection with the national migratory bird management program . ." subject to numerous conditions and reservations. The Department of Army reserved "all rights . . . not . . . specifically granted . ...." and specifically reserved the right to change water surface elevations, to dredge and dispose of spoil, to dispose lands for commercial and industrial sites, and to issue leases for accommodating public uses of the land. And, given the Federal objective, no refuge use could interfere with navigation. The cooperative agreement did not specify any of the rights or uses which the Service could exercise over "Red lands." The failure to enumerate which rights the Service obtained over lands transferred through the cooperative agreement made it practically impossible to determine just which rights the Service obtained. Calls for further negotiations on this subject began shortly after the documents were signed.

The 1961 General Plans and 1963 Cooperative Agreement

With the passage of the 1958 Coordination Act Amendments, all parties agreed that the general plans and cooperative agreement needed to be renegotiated. Among other issues addressed was the transfer of land from the COE directly to the states, then made possible by the act amendments. The 1958 amendments clarified the relationship between the Fish and Wildlife Coordination Act and other statutory authorities over federal activities regarding waterways. It directed that the consultation and modifications requirements contained within Section 2 applied retroactively to projects not yet 60 percent complete. Section 2(b) was added, requiring government agencies to give "full consideration" to the report supplied by the Secretary of the Interior regarding modifications of water projects for the protection of wildlife. Consequently, the Coordination Act clearly applied to future COE activities on the Upper Mississippi, and the COE was required to act on recommendations of the Secretary of the Interior to the extent necessary to comply with the full consideration requirement. Merely consulting with the Secretary of the Interior was insufficient.

Another of the 1958 Coordination Act Amendments added section 3(e) which settled the dispute over the relationship between the Coordination Act and the 1946 Flood Control Act. Section 3(e) stated that "Federal lands acquired or withdrawn for Federal water resource purposes and made available to the states or to the Secretary of the Interior for wildlife management purposes, shall be made available for such purposes in accordance with this Act, notwithstanding other provisions of law." The effect of Section 3(e) was to prohibit the COE from unilaterally issuing cottage siting or other public use leases or licenses on land turned over to the Refuge for wildlife management. In addition, the amendments clearly authorized direct transfers of land for administration by the states where such transfers would be in the public interest. The Service decided to allow the states to determine if direct transfers would be incorporated into the general plans. Direct transfers were of no concern to the Wisconsin Conservation Department because it did not administer any COE land for wildlife purposes. Iowa, Illinois and Missouri were opposed to any alterations in the 1954 transfer arrangements. Only Minnesota was interested in direct transfers for limited acreage in Pool 3, and that general plan was modified to allow for direct administration with the COE in that pool.[14]

Prompted by the 1958 amendments to the Fish and Wildlife Coordination Act, the FWS and COE developed a new system for coordinating public use of COE

[14] As a part of this planning process the Service asked Illinois, Missouri and Iowa to review the status of General Plan lands managed by their departments to determine whether they now be in favor of a direct transfer from the COE. Each of the States have reaffirmed the status quo arrangement.

land with other Refuge activities. Section 10 was added to the cooperative agreement whereby the COE retained the authority to develop public use facilities and issue leases in coordination with the Refuge's programs. In line with Section 10, a zoning plan was to be developed "whereby specific areas for public use, recreational [sic], cabin sites, etc." would be designated. The COE agreed to stop issuing cottage site leases and to phase out existing leases and agricultural leases. In their stead, the COE planned to convert some cottage sites into public access, camping, picnicking or boat launching areas. Section 6 was added to require the consent of both the Department of Interior and the Department of the Army before any rights of way for roads, telephone lines, power lines or other uses over either COE or FWS lands. Thus, involvement of both Departments was required for the approval of public uses and grants of rights of way. In addition, the 1963 Cooperative Agreement provided authority to the Service "to prevent and eliminate any trespass or unauthorized use" of property made available through the cooperative agreement.

One of the objectives of the 1958 negotiations was to provide for a system whereby minor changes in the land categories covering transferred lands could be made without requiring the signatures of the Secretaries of the Army and Interior. A provision was made in the general plans which allowed that "minor adjustments may be made in the boundaries . . . by mutual agreement" between the District Engineer, Regional Director, Service, and the appropriate state official.

File Photo

Mark Twain Refuge Established

In the late 1940s several GP land units managed by the Service south of the Quad Cities were designated separate national wildlife refuges administered by the Upper Mississippi River National Wildlife and Fish Refuge through publication in the Federal Register. These Refuges were located at Batchtown, Calhoun, Louisa, Keithsburg and Flannigan Island[15]. Due to the great distances involved in dealing with issues south of the Quad Cities from Winona, Minnesota, a proposal was made in June 1957 to "divorce the management of the Corps of Engineers land which have been made available to the [Service] south of Rock Island from the administration of the Upper Mississippi River Wildlife and Fish Refuge." In a memo to the Director dated October 31, 1957, the Regional Director stated, "it would be logical to designate these lands as a single refuge unit and suggest the Mark Twain National Wildlife Refuge as an appropriate refuge designation. This is a very logical name for the refuge, since it encompasses those portions of the

[15] The process to transfer additional COE lands at Flannigan Island to the Service was begun in 1957. Following the addition, this unit was referred to as Gardner Refuge, and later Gardner Division of Mark Twain NWR. Since this name never resonated with the public, as a result of this planning process the division is now referred to as the Long Island Division, as it is known locally.

Mississippi River which were made famous by the writings of Mark Twain." The memo also stated that the refuge should "establish a new headquarters office for this area somewhere in the vicinity of Quincy, Illinois."[16]

A news release dated August 1, 1958, stated that "Secretary of the Interior, Fred A. Seaton signed a document giving official Refuge status to certain lands along the Mississippi River between Rock Island and Alton, Illinois. The new Refuge, comprising some 20,000 acres in Illinois, Iowa and Missouri will be known as the Mark Twain National Wildlife Refuge." The release also stated that portions of the Refuge would be designated for public hunting, while other important waterfowl concentration points would continue to be maintained as sanctuaries for migratory birds and other wildlife. On August 28, 1958, the Director published a Notice of Proposed Rule Making in the Federal Register to permit the hunting of game birds and mammals on certain lands of the Refuge. At the time of establishment the Refuge contained the following lands, by county: Iowa (10,328) - Muscatine, 1200; Louisa, 6064; Des Moines, 3,064; Illinois (9,909) - Mercer, 1,466; Adams, 1,426; Calhoun, 6,409; Jersey, 608; Missouri (232) - St. Charles, 232; for a total of 20,469 acres. At the time an additional 2,500 acres on Long Island in Adams County, Illinois was in the process of being transferred from the COE to the Service. In 1958, the State managed GP land areas totaled 43,643 acres. Of that total 3,134 acres were in Iowa, 28,141 acres were in Illinois and 12,368 acres were located in Missouri.

During the 1940s and 50s, the exact legal status of state managed GP lands within the system of lands managed as National Wildlife Refuges in the Bureau of Sport Fish and Wildlife was uncertain. After the establishment of Mark Twain Refuge in 1958, and the subsequent legislation relating to the National Wildlife Refuge System, the status of state managed GP lands were further confused.

General Plan (GP) Lands and the National Wildlife Refuge System

In 1966, Congress passed the National Wildlife Refuge System Administration Act (NWRSAA), for the express purpose of "consolidating the authorities relating to the various categories of areas that are administered by the Secretary of the Interior for the conservation of fish and wildlife." The Act also provided the Secretary of Interior with the authority to acquire land or interests in land in exchange for existing acquired land. The NWRSAA did not explicitly include lands acquired through cooperative agreement, or address whether the provisions of cooperative agreements remained valid after the passage of the NWRSAA. Hence, prior to 1976, it was not clear that land acquired under cooperative agreement were within the National Wildlife Refuge System.

In 1976, the NWRSAA was amended by what became known as the Game Range Amendments. The amendments provided that suitable lands acquired through cooperative agreement were part of the National Wildlife Refuge System, but could be disposed of in accordance with the terms of the cooperative agreement. Questions were still raised regarding the effect of the NWRSAA, as amended, on the Upper Mississippi River cooperative agreement lands. The Game Range Amendments appeared to include only those cooperative agreement lands which were acquired before January 1, 1975, if sufficient managerial authority was transferred to the Secretary of Interior. In addition, the amendments appeared to allow only those provisions of the cooperative agreement to remain in effect that related to disposal of lands. The Acting Associate Solicitor for Conservation and Wildlife addressed these questions in a memorandum of August 8, 1980. He concluded that the Secretary of the Interior had the authority to enter into cooperative agreements for lands that would be included within the National Refuge System, whether or not entered into before or after January 1, 1975. The wildlife lands would be part of the System on the terms contained in the cooperative agreements without regard to the managerial authority reserved to the cooperating agency. He concluded that it was unreasonable to believe that Congress intended to rewrite management arrangements for lands under cooperative agreement to give the Secretary of the Interior total managerial authority. Thus, lands that are managed by the Fish and Wildlife Service under cooperative agreement, whether entered into before or after January l, 1975, are part of the National Wildlife Refuge System under the terms for management and disposal as contained in the agreement. Thus, GP lands managed as part of the Mark Twain Complex are subject to all the laws and policy of the National Wildlife Refuge System, including compatibility, to the extent of the authority granted to the Fish and Wildlife Service in the cooperative agreement.

On October 9, 1997, the President signed Public Law 105-57, "The National Wildlife Refuge System Improvement Act" (RIA), which amended the NWRSAA. The RIA spoke to elements of "Coordination Areas" within the National Wildlife Refuge System (NWRS). According to the NWRSAA Act, "the term 'Coordination Area' means a wildlife management area that is made available to a State....by cooperative agreement between the United States Fish and Wildlife Service and a state agency having control over wildlife resources pursuant to Section 4 of the Fish and Wildlife Coordination Act (16 U.S.C. 664)...." The term 'Refuge' is defined as a designated area of land or water, or an interest in land or water within the system, but does not include Coordination Areas. The House Report on the Refuge Improvement Act gives a good understanding of the intended relationship of these particular state managed areas and the issue of compatibility. It states that while these areas are considered a part of the Refuge System, they are specifically excluded from the definition of the term 'Refuge' so as not to require every state management decision to be approved by the Service. Thus, Coordination Areas are a part of the NWRS, but are not a part of any particular Refuge and are not subject to refuge compatibility standards. Each area is subject to the provisions of the Cooperative Agreement between the state and the Service, and as a part of the NWRS it is intended that each will contribute to the mission of the Refuge System. The mission of the System is to administer a national network of lands and waters for the conservation, management and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

The Mark Twain Refuge Complex is deeply entwined with the COE on the lands and waters of the Mississippi River. The Cooperative Agreement, included in Appendix D, was revised during the CCP planning effort and details those topics in which the COE has retained authorities that affect Refuge operations, procedures and compatibility. This agreement covers all GP lands managed as part of the Mark Twain Complex, the Upper Mississippi River National Wildlife and Fish Refuge and those lands passed on to the states of Missouri, Illinois and Iowa through step-down agreements with the Service. These state agreements now need to be revised to reflect the provisions in the new Cooperative Agreement with the COE for all lands and to ensure that the agreements are framed to contribute to the Mission of the NWRS. In a letter to the Chicago COE Division on February 4, 1977, the Regional Director designated the Mark Twain Refuge Manager as the point of contact for state managed GP agreement issues. As such, the Complex Manager will initiate the agreement revision process with each of the states.

Description of Existing Units within Mark Twain NWR Complex

The Mark Twain National Wildlife Refuge Complex is currently comprised of approximately 44,300 acres and stretches from Muscatine, Iowa, to Gorham, Illinois, covering approximately 342 river miles. This Complex consists of a Complex Office located in Quincy, Illinois, and five Refuges: Port Louisa NWR; Great River NWR; Clarence Cannon NWR; Two Rivers NWR and Middle Mississippi River NWR. Each individual Refuge is composed of separately named divisions scattered along the River corridor. Clarence Cannon NWR is managed as a unit of Great River NWR. The Iowa River Corridor Project (IRCP), which is managed primarily by the Iowa Department of Natural Resources through a cooperative agreement, is administratively a part of the Port Louisa NWR. Much of the Complex (approximately 17,000 acres, with some adjustments pending in St. Louis District Master Plan) is General Plan lands owned fee title by the COE, but managed by the Fish and Wildlife Service under the 1963 cooperative agreement. The units managed by Refuge staff vary in habitat from bottomland hardwoods to moist soil impoundments to grasslands and croplands. All Refuge divisions experienced dramatic habitat changes from several flood events in the 1990s. Also, four new divisions were purchased following the Great Flood of 1993. These were lands made available on the market due to flood impacts on private farm operations in the floodplain. In addition to the divisions listed in the following paragraphs, the refuges also administer several fee title land units acquired from Farm Services Administration.[17]

Mark Twain NWR Complex File Photo

[17] See section on "Refuge Management of Lands Associated with Agriculture Department (USDA)" at the end of this chapter.

Port Louisa NWR

The Port Louisa NWR is based 6.5 miles east of Wapello, Iowa, and is the northernmost of the Refuges. Refuge staff manage four divisions: Louisa, Big Timber, Keithsburg and Horseshoe Bend, totaling approximately 8,373 acres. Louisa, Big Timber, and Horseshoe Bend are located in Louisa County, Iowa, while the Keithsburg Division is in Mercer County, Illinois. Louisa, Big Timber and Keithsburg are located within the floodplain of the Mississippi River and are primarily General Plan (GP) lands. Horseshoe Bend Division lies within the Iowa River floodplain and was purchased fee title by the Service following the Flood of 1993.

Big Timber Division

The 1,758-acre Big Timber Division is located 2 miles south of Muscatine, Iowa, in Pool 17, along the right descending bank. The Division is comprised of a 1,252-acre contiguous backwater area as well as Turkey, Turkey Towhead, Otter, and Ramsey islands, which total 506 acres. Turkey, Turkey Towhead and Otter islands lie just above Lock and Dam 17 (RM 437-439), while the backwater portion of Big Timber stretches from RM 443-447. Ramsey Island is located at RM 443, just above the mouth of Big Timber's confluence with the main channel of the Complex connected to the Mississippi River. Big Timber Division is entirely General Plan lands. The bulk of Big Timber Division is a contiguous backwater of the River, consisting of sloughs surrounded by bottomland hardwoods. It is not protected by a levee and is completely open to the River's fluctuations. The area generates good Wood Duck production, as well as good numbers of neo-tropical birds and some Hooded Merganser.

Early in Big Timber's history as a refuge, several small fields were farmed near the north end, but the last 26-acre field was abandoned in 1984 and planted with bottomland hardwood seedlings. Prolonged flooding during 1993 and subsequent floods have caused many mature trees to die and become wind-thrown, leaving large openings in the canopy. Bur cucumber, an early successional invasive vine, is now the predominant ground cover in these large openings, but silver maple and green ash seedlings are beginning to regenerate. The unit's backwaters contain very little aquatic vegetation due to sedimentation and the lack of a soil consolidation and drying cycle.

Big Timber is open to waterfowl hunting. However, fishing is the Division's primary recreational attraction. Bank fishing is available at the parking lot/ramp site. The fisheries resource has slowly declined as sedimentation has accumulated in the backwaters. Deepwater habitat was created in the early 1990s when the Environmental Management Program (EMP) completed a dredging project through Round Pond continuing to the tip of Big Denny. However, since project completion, a great deal of sedimentation has occurred within the dredge cuts. This is due primarily to extensive flooding, particularly the 1993 flood. This project also included mast tree plantings on dredge spoil sites.

Access to the four islands of the Division is only by boat. The islands have been subjected to extended flooding during the past 10 years, which has significantly impacted the forest resources. Siltation in Swift Chute (between Turkey and Otter Islands) has decreased navigability, reduced submerged vegetative growth, and reduced habitat diversity in the remnant sloughs located within the island interiors.

Louisa Division

The 2,609-acre Louisa Division stretches from RM 438 to RM 441, right descending bank (Iowa). It is protected from average to moderate flooding by a COE levee stretching to Lock and Dam 17, approximately 1 mile south of the Division border. The levee is integral to maintaining the 9-foot navigation channel due to its proximity to the dam. However, seep water from the navigation pool makes some units in the Division difficult to manage. The Port Louisa Refuge headquarters area includes 48 acres of wooded bluff, a 4-acre prairie restoration and the office building site situated on the bluff overlooking the Mississippi River floodplain. Only this upland administrative acreage is owned fee title by the Service; the remaining acreage is General Plan lands.

Traditional waterfowl management has been the primary objective on this Division since its conversion from an agricultural levee district in the 1940s to a national wildlife refuge. Some cropping still occurs on the slightly higher elevations, but 800 acres are dedicated to promoting growth of moist soil plants for use by waterfowl. Other habitat types include a permanent 45-acre body of water (Prairie Pocket), and bottomland forest. Existing hardwoods in the floodplain were devastated by prolonged flooding in 1993 and a high percentage have died, although the 18-acre pecan grove continues to survive. A small 25-acre sand prairie was established on the highest ridge of Louisa Division in 1985. Even though this site was inundated by 1993 flood waters, some warm season grasses and forbs survived and prescribed burning on the unit has helped invigorate the stand.

Louisa Division is bordered to the south by Lake Odessa State Wildlife Area, which is managed by the Iowa Department of Natural Resources. Primary management on this area is for migratory waterfowl and fisheries. Lake Odessa and the Louisa Division share recently constructed water control structures at the north end (inlet from the River) of the Louisa Division, and south end of Lake Odessa (outlet). Water travels via gravity-flow through the inlet structure and is diverted into Louisa Division or sent on to Lake Odessa. The Refuge and Lake Odessa Unit coordinate water delivery to satisfy both management objectives. Often times both entities need flow at the same time.

Up to 330 acres are currently cropped on the Louisa Division. Corn, soybeans, buckwheat and winter wheat have traditionally been planted. Following the Flood of 1993, vehicle access to the Division was lost due to a large levee break. No mechanical manipulations occurred to deter natural succession, and the area quickly began converting to silver maple, cottonwood and willow saplings. In the last few years farming and burning have been used to reduce tree invasion in the moist soil units.

Louisa Division functions as a migratory bird sanctuary each fall and is closed to public entry. No hunting of any kind is permitted on the Division, however the adjacent Lake Odessa receives heavy hunting pressure. A concrete double boat ramp allows access directly to the River from the northern boundary of the Louisa Division. An accessible fishing pier allows fishermen to cast their lines into the diversion ditch leading to Lake Odessa.

Horseshoe Bend Division

Horseshoe Bend Division is located in the Iowa River floodplain, Louisa County, Iowa, approximately 4 miles upstream from its confluence with the Mississippi River. The 2,606-acre tract was purchased fee title by the Service in response to the Flood of 1993. Previously known as Levee District 8, privately owned agricultural fields were protected from the Iowa River by a levee built in the 1920s. Since its completion, the levee had been breached by floodwaters on an average of every 4 years. In 1993, floodwaters broke the levee at three sites, depositing large amounts of sand and debris across the floodplain and scouring many deep holes. Damage totaled $2.7 million. The landowners decided farming was no longer economically feasible, as their levee district taxes increased each time the levees breached. Due to the severe midwestern floods, the U.S. Department of Agriculture offered a program to affected landowners entitled the Emergency Wetland Reserve Program (EWRP). Eleven of the 13 landowners within Levee District 8 participated in the EWRP. The Service then offered each landowner with an EWRP easement the residual value to sell the land. Ten of the 11 landowners took the "buyout." The easements prohibit agriculture, but do permit the planting of food plots for wildlife.

Acquisition of Horseshoe Bend has reconnected the floodplain to the River by maintaining three breeches in the levee. During annual high water periods, floodwaters enter and exit the Division. The result is a mosaic of grassland, wet meadow, seasonal and semi-permanently flooded wetland, and forest. The wetland complex provides floodwater storage, and fish spawning and feeding habitat. The unit receives considerable migratory bird use including shorebirds, waterfowl, wading birds and grassland birds. There has been one active Bald Eagle nest on the Division the past several years

Since the property was transferred to the Service in 1995, many changes have been made to Horseshoe Bend's landscape. Approximately 400 acres of wetlands have been restored, 250 acres of former crop lands have been seeded with warm season native grasses and forbs, and 50 acres of mast-producing bottomland tree species have been planted. The unit contains the largest block of grassland/wet meadow habitat located in the AEC. Burning is the primary management tool used.

Horseshoe Bend Division is open to wildlife-dependent public use except during the fall, when it serves as a migratory bird sanctuary. Access to the Division is limited, however a public parking area exists on the west side off of F Avenue.

Keithsburg Division

The 1,400-acre Keithsburg Division is located between RM 428-431, left descending bank (Illinois). The entire Division lies within Pool 18, immediately north of Keithsburg, Illinois. An 8-acre boat ramp site is owned fee title by the Service; the remaining acreage of the Division is General Plan lands. The Division is a mosaic of wetland and bottomland forest habitat complex including sloughs surrounded by bottomland timber stands. The forested stands suffered from the Flood of 1993 and subsequent wind storms, and many snags now exist. Dead and dying trees are used by woodpeckers, Wood Ducks, Hooded Mergansers and Prothonotary Warblers. Bald Eagles also use the area during migration, and several nesting attempts have occurred. A 2-acre remnant sand prairie borders the east side of the public parking lot.

Keithsburg Division averages 0.75 mile in width and has a 3-mile-long levee separating it from the Mississippi River. The north end of the Division is bounded by a levee, but a spillway allows water from the Edwards and Mississippi Rivers to flow into the Division during flood events. Its eastern boundary is a sand escarpment that rises quickly from the floodplain. The southern containment boundary of the Division is the former Minneapolis and St. Louis Railroad right-of-way. This right-of-way, which acted as a levee separating Pope Creek from the Division, was breached during the Flood of 1993. In 1999, a spillway to provide River connectivity during periods of high water was constructed in cooperation with the landowner and the City of Keithsburg.

Mark Twain NWR Complex File Photo

The Keithsburg Division was previously an agricultural levee district in private ownership. The expense of trying to drain the area for farming became too much and the area was purchased in 1942 by the COE for the navigation project. In 1945, the area was transferred to the Service for management. Attempts to farm small fields continued, but were finally abandoned in 1984. The Division was established for protection of migratory waterfowl and has been managed accordingly since its establishment. Two 36-inch screwgates permit water levels to be lowered by gravity during summer months, allowing moist soil plants to grow in preparation for fall use by migratory waterfowl. A permanent pump station situated on the River levee was once used to facilitate lowering and raising water levels. However, this pump was damaged by the Flood of 1993 and is currently non-functional.

A recent contaminant investigation has indicated significant delivery of nitrogen and ammonia from neighboring watersheds into the northern portion of the Division, and it is an unresolved management concern. In 2000, CRP buffer strips were placed along private land drain ditches entering the Division to reduce sedimentation.

This Division serves as a sanctuary for migratory waterfowl during fall migration and is closed to public entry. Fishing is the primary public use on this Division, offering a diverse resource to bank, boat and ice fishermen. However, when the area is drawn down through the summer to promote moist soil vegetation, oxygen levels may become dangerously low for fish.

Great River NWR

The Great River NWR headquarters is located near the small town of Annada, Missouri, but is only 40 miles north of the sprawling St. Louis, Missouri, suburbs. Great River NWR staff manage three divisions for a total acreage of 10,146 acres and the Clarence Cannon NWR (3,750 acres). The Refuge also has management responsibility for two small fee title tracts acquired from Farmers Home Administration.

Fox Island Division
(formerly Gregory Landing Division)
The northernmost division is Fox Island, between the very small towns of Gregory Landing and Alexandria, Missouri, about 5 miles south of Keokuk, Iowa. It comprises approximately 2,109 fee title acres in Clark County, Missouri, adjacent to Pool 20, RM 354-358, right descending bank. The Division was formerly known as Gregory Landing, but was recently renamed in accordance

with local custom. The Fox River, which runs through southeastern Iowa and northeastern Missouri, bisects the Division and empties into the Mississippi River at the southern tip of the Division. A portion of the western boundary touches the Missouri Department of Conservation's Rose Pond Conservation Area. The original 1,037 acres of Fox Island were purchased in 1989 with additional purchases taking place in 1996 and 1997, in response to the record flood in 1993. Flooding events affect Fox Island both from the Mississippi and Fox Rivers.

A large percentage of the more recently acquired acreage had been in agricultural production. Oaks and pecans were planted on 160 acres in 1994, with an additional 80 acres planted in 1998. Wetland restoration within the Division is difficult due to the porosity of the soils, but three remnant sloughs have been partially restored by blocking agricultural drains with water control structures. Approximately 130 wetland acres have been enhanced by these efforts. Development of fixed pumping facilities is under consideration, but may be restricted by soil types and limited road access to the Division.

Other habitat available to wildlife includes marsh areas, one lake, slough channels and forested wetlands. Ninety acres of former cropland within the Mississippi/Fox Drainage District levee may be suitable for restoration of grasses. Approximately 675 acres are still planted annually with corn or soybeans by two cooperative farmers in order to keep the land clear for planned reforestation.

Fox Island is open to antlerless deer hunting during the Missouri state January extended season. It is closed to waterfowl hunting, but open to turkey and other upland game, except that it is closed October 16 to December 31. No public use facilities exist at this time and minimal "flood friendly" structures are proposed for development. Because only 90 of the 2,109 acres are protected by a levee, reliable access to this floodplain Division is limited by the River's fluctuations. A railroad track that traverses the Division contains an adjacent lane for railroad maintenance within their right of way, but is not open to the public.

Long Island Division

(formerly Gardner Division)

Long Island Division is located 6 miles north of Quincy, Illinois, in Pool 21, RM 333-340, left descending bank. The Division was formerly known as Gardner, but was recently renamed in accordance with local custom. This 6,300-acre non-leveed Division is comprised of a complex of islands and floodplain. Major islands include Barnes, Shandrew, Flannigan, Long and LaGrange. Wildlife habitat consists of about 4,670 acres of bottomland hardwoods, with lakes, sloughs and ponds making up an additional 600 acres. While extensive tree mortality occurred due the Flood of 1993, the unit is still the largest contiguous forest of its type south of Rock Island, Illinois. The size and diversity of trees makes the area unique along this portion of the UMR. In recent years a cooperative program with the COE has restored several hundred acres of farmland to hardwood habitat on Long Island. Less than 160 acres of crop lands remain on the Division at this time. The agricultural fields in the Bear Creek unit (124 acres) were restored to floodplain forest following the 1993 Flood.

Sedimentation in chutes and channels has greatly reduced depths and limited boat travel. Much of the sedimentation is due to training and closing structures needed for navigation. Quality of fishing has greatly declined due to sedimentation. The entire Division is open to hunting and fishing, in accordance with state regulations. The State of Illinois manages the waterfowl blinds through its 2-year permit allocation cycle. The Corps of Engineers manages the Bear Creek Recreation Area adjacent to the Division. This recreation area, which provides camping and boat access to the River, is used extensively by fishermen and hunters. In cooperation with the Corps of Engineers, a permit program is administered by the refuge for winter storage next to a Division island of private docks historically present along a portion of Canton Chute. An evaluation of this program was recently conducted, including its possible impacts to wildlife or habitat resources. When docks are moored properly, there is no evidence of negative impacts to the shoreline. Annual inspections will be conducted to ensure that trees or other resources remain unharmed. New permits for these docks will require that the most environmentally friendly material be used for floatation, which will have an off-site positive impact on the river. In addition, the Service will begin charging a fee for these permits to cover program implementation.

Delair Division

The 1,737-acre Delair Division extends from RM 277.5-282 along Pool 24 in Pike County, Illinois. The closest town is Louisiana, Missouri, 2 miles northwest of the Refuge. This Division was purchased fee title in 1965 and 1976 with funds from the sale of migratory waterfowl stamps. The Division lies completely within the 52-mile-long Sny Agricultural Levee District, and is separated from the River by the main line Sny Levee. The sandy soil structure and low elevation permits constant seepage of water into the Division from the River.

When originally acquired, the area was almost entirely cropland. Much of the Division has been restored to marshes, lakes, forest and grasslands. Semi-permanent and permanent water bodies make up 485 acres of Delair, providing feeding and resting areas for migratory birds and waterfowl. Water level management, mowing and discing are used to create diverse vegetation within moist soil units. Farming on this Division is used as a tool to provide supplemental food for waterfowl. Three hundred acres are being cropped currently by one cooperative farmer. Some loss of bottomland timber has occurred due to saturation of soils from flooding. However, the south Sny Levee was one of very few levees between Rock Island and St. Louis that was not breached during the 1993 flood event. Therefore, timber within Delair was not as extensively damaged as other divisions.

The Division is substantially protected from flooding by the Mississippi River by the main line Sny levee along the western refuge boundary. Additionally, all runoff and seep water from the Refuge are drained into the Sny ditch along the eastern boundary. These benefits provided by facilities of the Drainage District allow current management of refuge wetlands and other habitats. The federal government is not legally obligated to pay drainage assessments on lands that it owns. However, based on the benefits described above, under a 1967 cooperative agreement the FWS agreed to pay the Sny Drainage District a fee equal to the annual drainage assessment for refuge lands. Although this agreement expired in 1977, the FWS has continued to voluntarily make this annual payment. In recent years this amount has been approximately $11,400.

Delair Division is closed to public entry at all times, as stipulated in the purchase agreements. However, school groups often use the area for environmental education purposes. In 1993, it became necessary to control the expanding deer population and a muzzleloader deer hunt was initiated to assist with habitat management efforts. Either-sex permits and optional antlerless-only permits are issued to maintain burgeoning populations. Although no waterfowl hunting opportunities exist on the division, intense duck hunting pressure surrounds the Refuge, including Illinois Department of Natural Resources lease blinds on the Mississippi River.

Bald Eagles produced young in a nest along the southern boundary in 1998. A new nest was built within the Division in 1998 next to Upper Swan Lake and produced young in 1999, 2000 and 2001.

Clarence Cannon NWR

The Clarence Cannon NWR was established in 1964 through the purchase of migratory waterfowl stamp sales. It lies in Pike County, Missouri, between RM 261-264 in Pool 25. The headquarters for Great River NWR is located on Clarence Cannon. The area was formerly part of an agricultural levee district, and all but a few hundred acres are protected by a levee. This 3,750-acre unit was established to provide a feeding and resting area for migratory birds. The area is bounded on the east by the Mississippi River levee, on the south by the Bryants Creek levee and on the west by a levee that protects adjacent private crop ground and the small town of Annada, approximately 1 mile away.

Twelve moist soil units (2,000 acres) are disced, burned, mowed and cropped on a rotational basis to maintain a diversity of plants which, when flooded in the fall, provide excellent forage for migratory shorebirds, marsh birds and waterfowl. Peak waterfowl numbers may reach 100,000 in November and December. Over 400 acres on Clarence Cannon NWR are cropped by cooperative farmers annually. Corn, soybeans, winter wheat and clover are rotated through the crop fields and moist soil units to maintain diversity. Mast trees were severely impacted by the prolonged 1993 flooding. Over 80 percent of the pin oaks and hickories died, but some natural regeneration is occurring. Approximately 450 acres of bottomland forest remain. The flood also killed established warm season grasses.

Following the 1993 flood, an 800-foot spillway was built into the Mississippi River levee on the southeast side of the Refuge. This construction allows floodwaters to enter the Refuge more frequently at 4.5 feet below the levee top. Because of the spillway cut and spring high water events, timing for water management drawdowns has been altered. Monitoring of this frequent flooding is necessary to determine sedimentation rates within the Refuge. The spillway has provided increased connectivity to the River and temporary floodwater storage, which may help reduce downstream flooding on private lands.

Refuge visitors come to observe migratory birds, including Bald Eagles, waterfowl, shorebirds and neotropical migrants. Nesting marsh birds include the King Rail and Sedge Wren, both priority species of concern. One pair of Bald Eagles has nested the past several years. No hunting is allowed on Clarence Cannon NWR except for a special managed deer hunt in cooperation with the Missouri Department of Conservation to control the deer population. Portions of the Refuge are seasonally closed to public entry based on peak waterfowl migrations. Fishing is permitted by boat only in Bryant’s Creek, along the southern Refuge boundary.

Two Rivers NWR

Two Rivers NWR is headquartered near the small town of Brussels, Illinois, in Calhoun County, only 20 air miles from St. Louis, Missouri. The Refuge includes five divisions; four are located in the AEC but the fifth, Apple Creek Division, is outside the planning area and was acquired fee title from the Agriculture Department.

Batchtown Division

The Batchtown Division is within the Mississippi River floodplain of Calhoun County, Illinois, between RM 246 and RM 251.5 in Pool 25. The Division includes about 2,300 acres of forests, backwater sloughs, agricultural lands, lakes, ponds and moist soil units. A large portion of the Division, known as Prairie Pond, is separated from the River by a low elevation dike, making limited water level management possible on 400 to 550 acres during non-flood periods. A 52-acre moist soil unit is located next to Prairie Pond and also uses the low dike for water level management. More than half of the Division is open to River flood pulses and consists of a network of islands, side channels and backwaters.

The Division is adjacent to the Batchtown State Fish and Waterfowl Management Area on the south and the Red's Landing State Fish and Waterfowl Management Area on the north. Both are managed by the Illinois Department of Natural Resources. As part of the COE St. Louis District Master Plan, the Division was extended north to include a part of the expired Gilead private use lease area. The Refuge also transferred the lands south of Turner Hollow Road, including primary road maintenance and the Mississippi River boat access site, to the Illinois Department Natural Resources to create better interagency management use lines. Although the state assumes habitat management for this area, it was agreed that it would remain waterfowl sanctuary and that existing waterfowl blinds along the old boundary would not be moved any further north toward the Refuge.

Post 1993 flood improvements to Batchtown include three spillways in the dike/service road paralleling the River. The spillways were built 1.5 feet below road elevation to reduce future flood damage and increase River connectivity. Fish and waterfowl use of the Division has declined due to a decrease in habitat quality caused largely by sedimentation. There are approximately 1,600 acres of bottomland forest on the Division. Many mature trees have died due to extended flood events. Several former agricultural units were planted with mast-producing seedlings, however many of these did not survive subsequent high water. Construction of an EMP project began in 2000 and features habitat improvements on both the Refuge and state-managed areas. The Batchtown project includes dredge cuts for improved fish habitat, new water control structures for enhanced drawdowns, sediment traps and pumps.

Fishing is popular on Batchtown in spring and summer. The Division has one boat ramp at Prairie Pond, and another accessing the Mississippi River backwaters at Gilead. Service lands at Batchtown are managed as migratory bird sanctuary in the fall while the adjacent state-managed areas receive heavy pressure from waterfowl hunters. Some of the Division on the south end was open to hunting prior to the COE Master Plan land exchange of the Refuge General Plan lands with the Illinois Department of Natural Resources. Following the adjustment, the entire Division was closed to waterfowl hunting.

Calhoun Division

The Calhoun Division is located just north of the confluence of the Mississippi and Illinois rivers in Calhoun County, Illinois, and stretches along the Illinois

River from approximately RM 5 to 10. The 4,820-acre Division is comprised of the 2,300-acre Swan Lake, moist soil units, agricultural land, bottomland forests, grasslands, lakes, ponds, backwater sloughs, and Refuge headquarters.

An Environmental Management Program project on Swan Lake was nearly completed in 2000. The project included a low-elevation dike to separate the lake from the River (except during high flows), cross dikes to separate the lake into three management units (the lower two Refuge units and the state-managed upper unit), pumps and water control structures. An upland hillside sediment control component was added to the project in conjunction with the Natural Resources Conservation Service. By regaining water level management capabilities on Swan Lake, an occasional draw down will mimic historic conditions by consolidating the flocculent bottom and permitting conditions in which wetland vegetation can germinate. Lower Swan Lake will normally be open to the River for fish passage. Due to the results of the initial drawdown attempt in the summer of 2000, an additional pump is being planned for the south unit as a project performance follow-up.

During the St. Louis COE Master Plan process, the Division boundary was extended north to the cross dike between Refuge-managed Middle Swan Lake and state-managed Upper Swan Lake. The change established a more logical boundary between the two areas and added approximately 152 acres to the Division.

Prescribed fire is used to manage warm season grass on several higher elevation sites. Seven moist soil units totaling approximately 240 acres are managed for migratory birds. Silt deposition is a problem across the Division following floods. Approximately 550 acres of cropland are currently farmed by cooperative agreements on the Calhoun Division. Corn, soybeans and winter wheat are planted rotationally through the units. Approximately 25 acres of crop lands were removed from agricultural rotations and planted with bottomland hardwood tree species in 1994 and 1995.

Bald Eagles regularly use the area during winter. Visitors also enjoy the thousands of Snow Geese and other waterfowl that come to browse on the winter wheat and roost on Swan Lake. Bank fishing and small boat fishing is available. With the exception of the headquarters/visitors contact station, Calhoun Division is closed each fall to provide sanctuary for migratory birds.

Gilbert Lake Division

Gilbert Lake is adjacent to Pere Marquette State Park in Jersey County, Illinois, at Illinois RM 3.8 to 8. Gilbert Lake totals approximately 735 acres, consisting of a 250-acre lake bordered by forest, grassland and small agricultural fields. The area includes a 128-acre tract of land owned by the State of Illinois and managed by the Refuge under a cooperative agreement.

There has been a considerable amount of rehabilitation done on Gilbert Lake following the floods of 1993 and 1995. Improvements included upgrading and repairing the dike/service road that parallels the Illinois River, dredging silt from Gilbert Lake, and removing deposits from drainage ditches and silt basins. Two large spillways were built into the service road to reduce flood damage and permit regular river connectivity. However, due to an inoperable pump station, water level management for the past 15 years has consisted only of de-watering the lake by gravity through a stoplog structure. As on other River divisions, extended and recurring flood events have killed forest resources. The southern portions of the Complex, including Gilbert Lake, have suffered the greatest impacts.

The Duncan Farm Site has been identified as an important archeological resource at Gilbert Lake due to the Native American mound that is located on this area. A Federally-listed threatened plant species, *Boltonia decurrens*, or decurrent false aster, is also found on this Division.[18] At Gilbert Lake, this plant showed a marked increase in population following the extended flood events of 1993 and 1995, as documented by the Southern Illinois University – Edwardsville.

Public use on Gilbert Lake consists primarily of bank fishing and birdwatching. Gilbert Lake is closed annually during the fall as sanctuary for migratory birds, except for the overlook road adjacent to the highway. Bald Eagles use the area routinely during the winter and there are excellent viewing opportunities from Illinois State Highway 100. An active eagle's nest has been located on the Division in recent years. The Alton Convention and Visitors Bureau and Pere Marquette State Park conduct tours around the area for eagle viewing.

Portage Islands Division

Portage Islands Division's 230 acres are comprised of one large and three small islands in Pool 26 of the Mississippi River, RM 213-214. These forested islands lie just northeast of Portage des Sioux, Missouri. Backwater and ephemeral wetlands on the big island are used by waterfowl, wading birds, and other migrants. The three islands experience public use of the beaches by boaters during summer months. Illegal camping and campfires destroy vegetation on the islands each year. A great deal of bank erosion and island loss has occurred over the years. Hunting is not permitted.

Photograph by Jim Rathert

Middle Mississippi River NWR

The Middle Mississippi River NWR planning area begins below Lock and Dam 26 at St. Louis, and continues to the confluence of the Ohio River near Cairo, Illinois. There are no locks and dams in this reach, but the River has been confined to its main channel by rock training structures while large agricultural levees restrict lateral floodplain connection. The lands comprising the Middle Mississippi River NWR were purchased in response to the 1993 Flood, after the failure of various private levees. Currently, the acreage managed totals approximately 3,835 acres. Each existing Division is named an "Island," although the term is now misleading. At one time these areas were actual islands, but River structures intended to keep water flowing to the center of the navigation channel have caused sedimentation through the decades, accreting the island to the mainland and eliminating flowing side channels.

[18] See Current Status of the Area of Ecological Concern Resources, Endangered Species

Meissner Island Division

The 78-acre Meissner Island Division is located in Monroe County, Illinois, between RM 153.5 and 155.5, left descending bank. It is less than 20 river miles from St. Louis' southern suburbs. The Service purchased the residual value on these lands, which were enrolled in a perpetual Emergency Wetland Reserve Program (EWRP) easement from the Department of Agriculture. Due to its small size and limited access, little active management can be done on Division lands. The former cropland acreage is naturally regenerating with silver maple, willow and cottonwood. Noxious weed control is an ongoing problem on the retired agricultural fields in the area and is being treated on a spot-by-spot basis. Because of a lack of formal access no public use is currently permitted at this parcel, which may change with additional expansion at the Division.

Harlow Island Division

Harlow Island Division is located in Jefferson County, Missouri, between RM 140.5-144, right descending bank. The closest town is Crystal City, Missouri, 6 miles north.

The Service purchased this 1,225-acre tract in 1996. Nearly 800 acres had been cropland protected by a private levee that was breached during the 1993 flood. Following the fee title acquisition, the levee breaks were not repaired, which allows the Mississippi River into the floodplain during high water events. The cropland has been allowed to naturally revegetate and is now comprised of young silver maple, cottonwood and willow saplings. The remaining acreage is primarily bottomland forest with a small remnant side channel.

Harlow Island is closed to all migratory bird hunting. Archery deer and upland game hunting is permitted in accordance with state regulations. Access to the unit is limited since private land (Kimmswick Isle of Capri Casino, which is included in the Complex expanded boundary area) must be crossed to get to the north part of the unit. The southern part of the unit can be accessed from the adjacent Missouri Department of Conservation boat ramp site.

Wilkinson Island Division

The southernmost part of the Mark Twain NWR Complex is currently the 2,532-acre Wilkinson Island Division. This area is about 37 miles north of Cape Girardeau, Missouri, and lies between RM 88.5-93 in Jackson County, Illinois. Wilkinson Island was protected by a levee that was breached during the 1993 flood and has not been repaired. The landowners placed 1,900 acres of the island in EWRP easements; the Service paid residual value on this acreage and paid full appraised value for the remaining acres. There is one private landowner (780 acres) who is now surrounded by Refuge lands and the River. This landowner has an access easement across the Refuge to his land.

Natural revegetation has resulted in a thick stand of silver maple, willow and cottonwood saplings. A few residual side channels and wetlands remain throughout the area, but opportunities for restoration are limited by the desire to not negatively affect the adjacent private lands.

Hunting and fishing are allowed in accordance with state regulations. The Missouri/Illinois State line runs through the Division, but is not delineated on the ground. No parking lots, kiosks or informational panels are currently available for visitors.

Service Fee Title Properties Acquired From USDA

Three fee title tracts acquired by the Service through the Farm Service Agency (FSA)[19] are managed by the Complex refuges. The Apple Creek Division was acquired in 1992 and was initially referred to as a Wildlife Management Area (WMA). The Division is located outside the AEC, approximately 5 miles northwest of Carrollton in Greene County, Illinois. Apple Creek includes 269 acres of bottomland forest, shallow wetlands, and retired agricultural fields at the confluence of Coates Creek and Apple Creek. Roughly 105 acres are currently wetland, including the 30-acre Horseshoe Lake, 70 acres of seasonally flooded wetlands, and 5 acres in Apple Creek and Coates Creek. Another 160 acres are upland forest and retired agricultural fields reverting to forest. The Division is open to all the priority wildlife dependent public uses, except that the size of Apple Creek makes fishing opportunity quite limited.

Because Apple Creek is outside the AEC for this planning process it is not included in the same level of detail as areas within the 500-year floodplain. However, the unit contains high quality habitat that has the potential to be expanded and enhanced through acquisition and active wetland management. The unit contributes to the CCP water quality goal for the Complex by providing passive water treatment of an upland tributary (Apple Creek) that flows into the AEC. Several parcels of land adjacent to the Apple Creek property are also prone to frequent flooding and if acquired would add to the wetland habitat total in the area, as well as increasing the desirable effects on water quality. More specific management plans for the Apple Creek Division and other parcels in this section will be outlined in subsequent Habitat Management Plans.

In 1993, Great River NWR acquired a 43-acre tract in Lewis County, Missouri, within the Mark Twain AEC. It lies just north of the town of Canton, Missouri, and adjacent to Lock and Dam 20. Although partially protected by a levee, the area is subject to backwater flooding from the Mississippi River almost every spring. Farming was abandoned on the area in the early 1990s and the area is reverting to an early successional forest with silver maple and green ash.

The second fee title tract managed by Great River NWR is 80 acres in size and is located in Clark County, Missouri. It was also acquired in 1993. About half of the property was formerly cropland located along Hickory Creek. The cropland has been abandoned and is being allowed to naturally regenerate to bottomland forest. This has removed non-productive, highly erodible cropland from production and created a riparian buffer zone along the creek. The remaining half is established forest. The tract is not within the Mark Twain AEC.

Area of Ecological Concern Setting

Climate

The Mark Twain Refuge Complex AEC lies within the heart of the Midwest. The climate for this section of the country varies from cold in the winter to hot and

[19] This Agency was previously named Farmers Home Administration. Lands were acquired under the authority of the Food Security Act of 1985.

Table 2: Average Temperatures, Precipitation, Snowfall and Humidity in a Few Area of Ecological Concern Counties, from North to South.

Location	Average Winter Temp. (F)	Average Summer Temp. (F)	Average Precip. (Inches)	Average Snow (Inches)
Louisa, Iowa	25	73	37	37
Clark, Missouri	27	74	38	28
Pike, Missouri	30	75	37	18
Calhoun, Illinois	31	75	35	21
Jackson, Illinois	36	77	43	12

humid during summer months, and includes some variation from north to south. Table 2 shows the variation in average seasonal temperatures and precipitation in the north part of the complex (Louisa County, Iowa) to south (Jackson County, Illinois). Temperatures have been recorded within these counties as low as -25 degrees Fahrenheit (Calhoun and Louisa counties) and as high as 116 degrees Fahrenheit (Pike County).

Up to 70 percent (Louisa County) of the annual precipitation falls between April and September of any given year. Thunderstorms occur about 50 times per year throughout this corridor of counties. Severe thunderstorms, sometimes accompanied by hail, are usually localized. At least 1 inch of snowfall is present an average of 36 days per year in Louisa County and 6 days per year in Jackson County. The sun shines in the summer an average of 65 percent of the time in Louisa County and 75 percent of the time in Jackson County. Winters can be a bit dreary with only 40-50 percent sunshine throughout the corridor. The highest average wind speeds occur during the spring at around 11-12 mph.


Mark Twain NWR Complex File Photo

Information in this section was compiled from soil survey books from each county. Their source of data is the National Climatic Center, Asheville, North Carolina.

Geomorphology of the Upper Mississippi River [20]

The headwaters of the Mississippi River is at Lake Itasca, in Minnesota, at 440 meters above mean sea level. At Bemidji, the River flows through lakes Irving and Bemidji and then through Stump, Big Wolf, Andrusia, Cass, Winnibigoshish, and Pokegama lakes. The outlets of lakes Winnibigoshish and Pokegama were dammed in 1891 and 1884 as part of a U.S. Army Corps of Engineers navigation and flood-control system that included four other dammed reservoir lakes on Mississippi River tributaries. The headwaters' dams are now used mainly for

[20] Information in this section is largely taken from Theiling et al., Habitat Needs Assessment Technical Report, 2000; and Ecological Status and Trends of the Upper Mississippi River System, USGS, 1998.

flood control, recreation, conservation, and related uses. None of the 11 dams between Lake Itasca and St. Anthony Falls (in Minneapolis, Minnesota) have navigation locks.

The Upper Mississippi River flows 1,462 kilometers from St. Anthony Falls to the mouth of the Ohio River at Cairo, Illinois. The major period of valley scouring began about 15,000 years ago when the Wisconsin Glacier began to melt, increasing river flow. About 12,700 years ago, the retreating Wisconsin Glacier blocked the northward drainage routes of its meltwaters toward Hudson Bay, forming glacial Lake Agassiz. This huge lake spilled over its southern rim for about 2,700 years, forming the glacial River Warren and carving the large valley now occupied by the Minnesota River. The River Warren was much larger than the present Minnesota River but carried little sediment. The glacial St. Croix River provided additional sediment-free overflow from Lake Duluth (glacial Lake Superior). The combined flow of the two rivers greatly increased the erosive capacity of the Upper Mississippi River, enabling the River to remove sediments from its bed and to deepen its channel by as much as 90 meters. The Upper Mississippi River must have been spectacular at that time—a massive, torrential river in a gorge that was eventually scoured more than 250 meters deep. As the Wisconsin Glacier retreated into Canada about 9,200 years ago, inflows of meltwater to the Upper Mississippi River ceased. The Upper Mississippi River valley then began filling with glacial outwash, mainly sand and gravel, a process that is still under way.

Just upstream from St. Louis, Missouri, the Missouri River joins the Upper Mississippi River from the west. Most tributaries to the Missouri River flow through highly erodible soils, which means that the Missouri River has always been the principal supplier of sediment to the Mississippi. Construction of a series of large dams in the Missouri River basin in the 1950s and 1960s created deep, cold-water reservoirs that trap sediment, reducing the Missouri River's total contribution of sediment to the Mississippi by about 70 percent.

About 160 kilometers downstream from St. Louis, the Mississippi River flows through Thebes Gap, which resembles the stem of an inverted funnel. Where it exits the gap, the constricted river widens as it enters an ancient sediment-filled lobe of the Gulf of Mexico called the *Mississippi Embayment.* The Mississippi River valley expands to a width of about 50 miles where it meets the mouth of the Ohio River. Floodplain geomorphology provides the template upon which plant communities and habitats develop. The geomorphology and topographic features of the River are diverse along its length, and also laterally from the channel to the bluffs. The longitudinal profile of the Upper Mississippi River can be divided into at least 10 major geomorphic reaches. The limits of the reaches are defined as:

Geomorphic Reach 1:	Pools 1-3
Geomorphic Reach 2:	Pool 4 (Lake Pepin)
Geomorphic Reach 3:	Pools 5-9
Geomorphic Reach 4:	Pools 10 -13
Geomorphic Reach 5:	Pools 14 -17 (Refuge Complex reach starts in Pool 16)
Geomorphic Reach 6:	Pools 18 - 19
Geomorphic Reach 7:	Pools 20 - 22
Geomorphic Reach 8:	Pools 24 - 26
Geomorphic Reach 9:	Below Pool 26 to Thebes Gap

Geomorphic Reach 10:	Thebes Gap to Ohio River confluence (End of Complex river reach)
Geomorphic Reach IR2:	Illinois River (Alton and Peoria Pools) is also in the Complex AEC.

Soil types and the geomorphic setting are critical considerations when addressing river corridor restoration activities. Having the right habitat planned for the right place is dependent on an understanding of these factors before project features are constructed or modified. The Mark Twain Refuge Complex AEC begins within Reach No. 5, and extends through Reach No. 10. Geomorphic Reach 5 includes the highly constricted Fulton-Rock Island gorge in Pools 14 and 15, and the wide valley expansion in Pools 16 and 17. The portion of the reach through the gorge is a steep, constrained channel with few islands and little floodplain terrestrial area. The River flattens in Pool 16 and large islands were formed when sediment was deposited in a main stem delta downstream of the steep gorge. Island formation in Pool 17 is similar to Pool 16, but the valley widens significantly in the ancient Iowa River valley. The plan form (as seen from above) changes resulting from impoundment are not as apparent in Geomorphic Reach 5 compared to upstream reaches. Agriculture is an important component of the floodplain landscape; levees protect 12 percent and 74 percent of the Pools 16 and 17 floodplain, respectively.

Geomorphic Reach 6 consists of Pools 18 and 19. Pool 18 and upper 19 are similar to Reach 5, with many large islands and secondary channels. Impoundment effects are not pronounced in lower Pool 18. Lower Pool 19 was a steep rapids through a geologically young rock gorge from Fort Madison to Keokuk, Iowa, prior to impoundment, but the hydroelectric dam constructed in 1913 inundated the gorge. Lock and Dam 19 creates a 38-foot head that impounds about one-half of the 46-mile-long reach. Much of the impounded area has filled with sediment and aquatic plants now grow in areas that were 30 feet deep when the dam was constructed. The dam is the major impediment to fish migration throughout the basin. The broad floodplain upstream from the gorge has largely been converted to agriculture. Slightly more than 30 percent of Reach 6 is leveed.

Geomorphic Reach 7, including Pools 20, 21, and 22, is a surprisingly steep reach due to sediment from the Des Moines River entering the Mississippi below Lock and Dam 19. The reach shows evidence of old meander belts through the post-glacial alluvial soils. Large island complexes and long interconnected secondary channels characterize much of the reach, but relatively simple channel reaches are evident too. Lower pool impoundment effects are not pronounced in plan form. Agriculture is the dominant floodplain landscape element. The floodplain in the reach is about 70 percent leveed.

Geomorphic Reach 8 includes Pools 24, 25, and 26. The slope of the riverbed decreases through the reach to the hump of the Illinois River and Missouri River alluvial fans. The Missouri River contributes most to this feature due to the lower flow and higher suspended sediment component of the Illinois River. Upper reaches of the pools have numerous large islands and mostly simple single thread secondary channels. Lower pool reaches generally have smaller and fewer islands. Impoundment effects are noticeable immediately upstream from Locks and Dams 25 and 26. Agriculture is the dominant floodplain landscape element. About 70 percent of Pools 24 and 25 is leveed. Only about 23 percent of the Pool 26 floodplain is leveed on the available GIS coverages, but levees visible on topographic maps do not appear on the GIS maps. The coverage needs to be verified and updated.

Geomorphic Reach 9 includes the Mississippi south of Pool 26 to Thebes Gap at RM 48. The floodplain is about 7 miles wide and the River has meandered through it many times. The head of the reach is very steep due to the influence of the Missouri River alluvial fan. Prior to improvements for navigation the reach had many islands and ephemeral sand bars, but channelization and dredging have greatly simplified the river channel. Side channels provide most of the off-channel aquatic area and many are being lost to sedimentation and river training efforts. Closing structures and wing dams divert moderate and low flow currents away from, and often isolate, side channels, so only sediment-laden flood flows influence the secondary channels. Scour holes below closing structures may be 50-100 feet deep and experience episodic periods of poor water quality when isolated from the River. Eight secondary channels were lost between 1880 and 1960, another two were lost between 1960 and 1989. This process has slowed somewhat since huge quantities of sediment delivered from the Missouri have been diminished with the construction of the Gavins Point Dam on the Missouri River in 1955. River bed degradation (i.e., scour) has significantly deepened the highly regulated channel. The floodplain is over 70 percent leveed, with agriculture dominating the landscape.

The river channel in Geomorphic Reach 10 (Thebes Gap to the Ohio River) is very similar to Reach 9, but the floodplain widens greatly below the rock gorge at the upstream end. The floodplain widens to about 10 miles and the River has two large bends. The bed slope continues to be steep due to scour through the gorge. The same impacts from navigation displayed in Reach 9 are operating in Reach 10.

The lower Illinois River reach, including Peoria, La Grange, and Alton pools, is a remnant of the ancient Mississippi River that once flowed across northwestern Illinois. Glacial flows down the ancient valley created a floodplain that is exceptionally large for the current river discharge. The floodplain has been filling with fine loess sediment for millennia and the current channel slope is very low. The three navigation pools in this reach are about twice as long as the longest Mississippi River pools. The modern river channel is relatively simple, with few islands and side channels, but many backwaters of differing degrees of connectivity fringe the channel. Prior to navigation and agricultural development, Illinois River backwaters were very numerous and diverse in shape, size, and depth. Currently, water level regulation maintains fewer, larger lakes with uniform shallow depths and silty substrates. Agriculture dominates the floodplain, which is about 50 percent leveed in the La Grange Pool and about 70 percent leveed in the Alton Pool.

Lateral Variation of Geomorphology

Lateral variation in UMR floodplain morphology is very diverse, but some generalities can be described based on geomorphic and navigational features of the river system (Wilcox 1993).

The main navigation channel in most of the UMRS is 300 feet wide in straight reaches and 500 feet wide in bends. The prescribed depth of at least 9 feet is maintained by navigation dams, channel training structures, and dredging. The main navigation channel is a high current velocity environment with shifting sand substrates.

Tailwaters are the areas directly downstream of the navigation dams. They have deep scour holes, high velocity, and turbulent flow. This is a hydraulically severe environment with boulder, cobble, gravel, and shifting sand substrates.

Channel borders are the areas between the navigation channel and the river banks. Channel borders are narrow in upstream portions of the pools, where banklines are steep and the main channel is narrow. Channel borders are widest in the lower reaches of the pools where water is impounded by the dams and many former floodplains are inundated. Substrates vary with current velocity but include sand, mixed sand, silt and/or clay, or fine silts and clays. Submersed aquatic plants, submerged logs, rip rap, and wing dams, where present, provide habitat for many aquatic animals.

Secondary channels are large channels that carry less flow than the main channel. Some may be obstructed at their upstream ends by closing dams that may lead to rapid filling with sediment. Secondary channel habitats can be quite variable depending on their connectivity with the main channel, age, size, and substrate. Large, highly connected secondary channels provide habitats similar to the main channel. Smaller less connected secondary channels provide lower current velocity, finer sediments, and may have more log jams and aquatic plants.

Tertiary channels are small channels (less than 30 meters wide) splitting off secondary channels in braided river reaches. Tertiary channel habitat can be quite variable depending on its connectivity with other aquatic areas and tree cover. High current velocity tertiary channels are likely to have sand and gravel substrates and few plants. Low current velocity tertiary channels may be quite “backwater-like,” with silt/clay substrates. Herbaceous plants may be present if light filters through riparian forests.

Tributary channels are channels of tributary streams and rivers. Tributary channel habitats differ with size of the stream or river. Larger streams and rivers may be important for certain migratory fishes, while small bluff line tributaries provide little habitat for river species. Tributary deltas are sometimes highly dissected with abandoned channels, scour holes, and natural levee ridges created by the meandering of high gradient tributary channels across erodible floodplain. The diverse physical structure of tributary deltas promotes high biological diversity. Tributary channels provide fish shelter from harsh conditions in the main channel. Many tributaries have been degraded by fine sediment and sand eroded from the watersheds. Tributary channels in leveed areas are highly controlled and channelized.

Contiguous backwater floodplain lakes are hydraulically connected to the River at low flow. Isolated backwater floodplain lakes are floodplain water bodies that do not connect with the River at low flow. However, they are frequently inundated during higher river levels permitting exchanges of sediment, nutrients, plants, and animals. All provide similar low current velocity habitat. Backwater lakes provide habitat to a wide variety of plants and animals adapted to low flow conditions. Most submersed and emergent aquatic plants are adapted to the shallow, relatively clear water of UMRS backwaters. Many fish and wetland bird species live and feed on and among aquatic plants. Lower pools and the Lower Illinois River have far fewer backwaters than upper pools and fine sediments are frequently resuspended by waves, thus creating constant high turbidity that prevents aquatic plant growth.

Islands are especially numerous in pools 1 through 13 and in mid-pool reaches of other pools. Islands and sand bars were once numerous in the Open River reach, but channel training and dredging has destroyed most islands since improvements for commercial navigation were initiated. Many islands in contiguous backwater impounded areas have been eroded by waves. Islands are typically sand based and capped with fine silts and clays deposited during floods. Islands are typically wooded. Islands create habitat diversity for aquatic species allowing submersed aquatic plants to grow in their "flow shadow." Islands also provide flow refugia for fish, and reduced predator problems for nesting birds.

Contiguous floodplain areas include all non-island terrestrial habitats subject to flooding. Small differences in contiguous floodplain physiography are poorly defined due to a lack of high resolution topographic data to delineate important features of floodplain terrestrial areas. Much of the contiguous floodplain is inundated each year, but the distribution of floodwaters is impossible to predict given current terrestrial elevation data. Wet floodplain forests dominate the lowest elevation contiguous floodplain areas (i.e., most frequently flooded), and mesic bottomland forests occur in the higher elevation or better-drained areas. Terraces are likely to support savanna and grassland habitats, but most have been converted to agriculture.

Isolated floodplain areas are protected from moderate flooding by constructed levees. Most of the land area protected by levees has been converted to agriculture, but urban areas and small towns are also protected. Much of the land in leveed areas has been leveled to facilitate farming, thus filling small wetlands and backwaters. Tributaries and former channels are highly channelized and water levels are often controlled with pumping stations. Native plant communities composed of oak groves, savannas, and grasslands are largely absent since the conversion of hundreds of thousands of acres to agricultural use. Large communities of prairie birds, reptiles, and large herbivores have been either extirpated or suffer from lack of habitat.

Many aquatic areas have been modified with features known to affect habitat quality. Wing dams are rock structures usually constructed perpendicular to the river to constrict flow in the main channel. Wing dams create unique hydraulic eddies and scour holes in their downstream shadow that are often used by fish. Wing dams can also have negative impacts where the area between wing dams becomes filled with sediment and converts to terrestrial floodplain area. Rip rapped shorelines are covered with large grade limestone to prevent bankline erosion and river meandering. The banks are cleared of vegetation, graded to a stable slope, and covered with rock. The rock substrate provides stable habitat for macroinvertebrates that frequently colonize the rock in very high densities. Fish of many types live in or in proximity to the rock structure.

Socioeconomics

Two economic studies help characterize the importance of refuges to local community economies and, more specifically, the economics of the Mississippi River corridor counties. The first is the Service-produced "Banking on Nature: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation" in 1997. This report is the first of a multi-phase study investigating the impact of national wildlife refuges on their local economies. The report discusses income and employment effects that recreational visitors to refuges have on the economies of local regions. In addition to the economic effects of refuge hunting and fishing programs in local communities, it measures the economic impact of "eco-tourism," the relatively recent phenomenon of large numbers of people traveling substantial distances to take part in non-consumptive uses of the natural environment. Eco-tourism is one way to derive economic benefits from the conservation of wildlife and habitat. The study found that:

- Recreational visits to national wildlife refuges generate substantial economic activity. In Fiscal Year 1995, people visited refuges more than 27.7 million times for recreation and environmental education. Their spending generated $401.1 million of sales in regional economies. As this spending flowed through the economy, more than 10,000 people were employed and $162.9 million in employment income was generated.

- Non-consumptive use of wildlife at refuges generated far more economic activity than hunting and fishing. Although non-consumptive wildlife users usually stay for shorter periods of time and spend less, their numbers at many refuges far exceed those of hunters and anglers and more than compensate for lower spending per person (Laughland 1997). This is a relevant fact to the conditions throughout the Mark Twain complex. Since much of the Complex is managed as sanctuary that is surrounded by areas open to hunting, wildlife observation can be accommodated at most Complex locations during the fall.

The second study the Upper Mississippi River Conservation Committee directed was the "Economic Profile of the Upper Mississippi River Region" report. This study provides a snapshot of current regional economic activity dependent on the Upper Mississippi River.

The profile by Black, et al., encompasses economic activity in all 60 counties in five states bordering the Mississippi River, including 26 that are north of the AEC. Specific data to the Mark Twain corridor counties cannot be extrapolated from the totals, but generalities can be implied. The Refuge Complex does not include any of the 17 Minnesota or Wisconsin counties included in the report, but does consist of 14 (of 18) Illinois counties, 5 (of 10) Iowa counties, and 14 Missouri counties. The report uses available databases and literature to characterize 10 key economic sectors listed below.

<u>Commercial Navigation</u> – The waterway transportation industry ships 125 million tons of commodities on the UMR every year. These commodities consist primarily of farm products (55 million tons), coal (24 million tons), and non-metallic minerals (21 million tons). Commercial navigation generates about $1 billion in revenues per year and employs approximately 6,300 people.

<u>Harvest of Natural Resources</u> – The primary commercial harvest activities are fishing, musseling, and trapping. Depending on the harvest year, revenues vary from about $4 million to $9 million and employment varies from 1,200 to 4,000 people. While commercial fishing and trapping have remained stable in recent years, musseling has declined dramatically.

<u>Water Supply</u> – About 7.2 billion gallons of water are withdrawn from the UMR each day for use by the energy, agriculture, mining, manufacturing, and water supply vectors. Most of this water (6.4 billion gallons per day) is used as cooling water in the energy production process and returned to the River. Twenty-two cities obtain drinking water from the UMR as well. Public water supply systems employ about 1,000 people and generate about $130 million in annual revenues.

<u>Recreation</u> – People enjoy more than 11 million recreational visits to sites along the UMR each year, with most people engaging in fishing, boating, hiking or

sightseeing. This recreation generates more than $200 million in revenue for local businesses. The economic importance is even greater when other recreation in the region that depends on the UMR's ecology is taken into account. For example, about 40 percent of all waterfowl in North America rely on the Mississippi Flyway; waterfowl hunting and viewing generate over $1 billion in revenue in the UMR's five-state region.

<u>Tourism and Cultural/Historical Resources</u> – Tourists come to the UMR corridor to visit the more than 1,700 cultural landmarks and sites, and to enjoy River festivals, riverboat tours, and riverboat gaming. Leisure travelers to the corridor spend about $6.6 billion per year, which supports about 140,000 jobs, mostly in the hotel, restaurant, and retail industries.

<u>Mineral Resources</u> – The primary mining activities in the corridor are crushed stone, coal, sand and gravel, cement, and lime production. These mining operations generate over $1.2 billion in revenues per year and employ over 6,500 people, mostly in Missouri and Illinois.

<u>Agriculture</u> – The corridor's 52,600 farms generate more than $5 billion in revenue per year and employ 94,000 people (including part-time and seasonal workers). Corridor farms primarily produce corn, soybeans, cattle, hogs, and dairy products. These products are used as inputs to food processing industries, which produce commodities such as corn oil, fructose, soybean oil, processed milk, and meat products.

<u>Energy Production</u> – The corridor's 49 power plants generate about 7,500 megawatts of electricity per year, about 20 percent of the total power generated in the UMR five-state region. The energy sector depends on the River for cooling water, transportation of coal, and as a direct fuel source for hydroelectric generation. Power plants and distribution facilities in the corridor employ more than 13,000 people and generate $4.7 billion in annual revenues.

<u>Manufacturing</u> – The corridor's manufacturing sector is composed of numerous diverse industries, of which the largest are food processing, machinery, transportation equipment, and chemicals. Manufacturing generates $126 billion in annual revenue and employs over 600,000 people.

<u>Natural Resource Services</u> – The River provides many services that may not be directly reflected in the commercial economy.

> *Wastewater Treatment:* Approximately 280 facilities use the UMR as a "sink" for discharging wastewater. Dischargers include manufacturers and municipal sewage treatment plants.
>
> *Wetland Services*: Over 40,000 acres of wetlands in the corridor provide benefits associated with flood control, protection of water quality, water supply, and habitat for wildlife.
>
> *Wildlife Species and Habitat*: Environmental quality and the health of habitat and species have an intrinsic value, irrespective of human use. This value is reflected in the many past and ongoing efforts to restore and preserve UMR habitat.

Considered together, the 10 economic sectors in the five-state area account for about $145 billion in revenue to businesses in the corridor. Approximately 870,000 jobs are associated with this economic activity. The revenue generated by the 10 sectors represents about 40 percent of the total output of the corridor, and 18 percent of the economic activity in the five-state region.

Another study, conducted by Carlson et al. (1995) , measured recreational usage originating from developed sites along the Upper Mississippi River and the Illinois River. This study produced basin-wide estimates of the total number of recreation visitors, the activities they engaged in, the amount of money they spent on recreation and the patterns evident in their spending. The researchers estimated that more than 12 million daily visits by recreationists took place during the study year. Boating was the most popular activity, with more than half of all visitors participating in this activity (6.9 million boaters).

Current Status of Area of Ecological Concern Resources

Fish and Wildlife

Several factors have contributed to the recent general declines in the River's fish, wildlife and habitat including sedimentation, toxic substances, nitrogen loading, commercial and recreational navigation, loss of plant and invertebrate food sources, invasions of exotic species and human disturbances. The continued accumulation of sediment in the navigation pools on the UMR will eventually destroy or degrade much of the aquatic habitat in the pools. Sedimentation is considered the biggest problem confronting the resources of concern for the Mark Twain Refuge Complex.

There are also some favorable biological trends on the Mississippi River. The abundance of Bald Eagles along the river corridor has increased, paralleling the national trend. Mink populations have begun to recover, probably due to the declines in PCB contamination of riverine fishes that followed the ban on production of PCBs. According to state furbearer biologists, other furbearer populations, such as otters, have increased and are stable at present.

Photograph by Jim Rathert

Birds

The Upper Mississippi River is a major bird migration corridor within North America. Millions of migratory birds use the Mississippi River corridor each year during fall and spring migration. The River's north-to-south orientation and nearly contiguous habitat make it critical to the life cycle of many migratory birds. Diving ducks, swans, pelicans, and cormorants use the River's large open water pools, and dabbling ducks, geese, herons, egrets, bitterns, and rails use the shallower backwater wetlands. Bottomland forests support resident and neotropical migrant songbirds, Bald Eagles, Red-shouldered Hawks, Mallards, Wood Ducks, Hooded Mergansers, and nesting colonies of herons and egrets. In 1986, Congress declared the Upper Mississippi River to be a nationally significant ecosystem.

Waterfowl

The Upper Mississippi River Valley is the primary fall migration corridor for 10 species, and is a secondary migration corridor of considerable importance for eight other species of waterfowl in North America. In addition, 13 other waterfowl species can be found regularly in smaller numbers during migration in the Upper Mississippi River (Reid et al., 1989).

Table 3: Waterfowl Species for which the Upper Mississippi River Valley is a Critical Migration Corridor.[21]

Primary	Secondary
Tundra Swan *Cygnus columbianus*	American Wigeon *Anas americana*
Lesser Snow Goose *Chen caerulescens*	Gadwall *Anas strepera*
Canada Goose *Branta canadensis*	Green-winged Teal *Anas crecca*
Wood Duck *Aix sponsa*	Black Duck *Anas rubripes*
Mallard *Anas platyrhynchos*	Northern Pintail *Anas acuta*
Blue-winged Teal *Anas discors*	Northern Shoveler *Anas clypeata*
Canvasback *Aythya valisineria*	Redhead *Aythya americana*
Ring-necked Duck *Aythya collaris*	Ruddy Duck *Oxyura jamaicensis*
Lesser Scaup *Aythya affinis*	
Hooded Merganser *Lophodytes cucullatus*	

The numbers of migrating waterfowl on the River fluctuate widely from year to year because of variations in waterfowl production on the breeding grounds, food resources, and weather. The Illinois Natural History Survey (INHS) has conducted aerial waterfowl counts along portions of the Mississippi and Illinois River corridors during fall migration since 1948. The purpose of these inventories is not to acquire exact waterfowl counts, but to estimate the number of each species in order to provide an index of change within and among years and to document the distribution of the species throughout the monitored region (Havera 1999). The following tables depict the percentage of ducks and Canada geese found on Refuge Complex lands, compared to the total counts in the Mark Twain Complex river reach in the fall of 1998 and 1999. These counts include lower Pool 16 through Pool 26 and the Illinois River confluence. Fall precipitation in 1998 was heavy, which may have provided more waterfowl habitat than normal. Fall precipitation levels in 1999 were average. Table 3 describes the waterfowl species for which the UMR is critical habitat; Table 4 depicts the INHS aerial duck counts for the Mark Twain Complex river reach; and Table 5 shows the INHS Canada goose counts for the Mark Twain Complex river reach.

The major wave of duck migration in Illinois typically occurs during the 2-week period of 10-23 November, while the largest wave during spring migration usually occurs during 14-27 March. Peaks of Canada goose migration occur 8-31 December and 15-28 February. Because species vary in their chronology of

[21] Primary importance is assigned to species for which the UMRV is the single or one of two major corridors in North America. Secondary is assigned to species for which the UMRV is a major corridor, but not the most important migration pathway in North America. Table from Reid et al. 1989.

**Table 4: INHS Aerial Duck Counts
Mark Twain NWR Complex River Reach**

Fall Migration Month	Ducks Counted on Refuge Complex	Total Ducks Counted	Percent of Ducks Using Refuge Lands
1998 (Wet Fall)			
October	96,250	194,410	50%
November	448,870	902,080	50%
December	497,875	1,069,880	47%
1999 (Average Fall Precipitation)			
October	152,705	240,775	63%
November	446,375	692,130	64%
December	372,405	649,890	57%
2000 (Dry Fall)			
October	59,905	78,145	77%
November	402,535	757,660	53%
December*	N/A	N/A	N/A

**Table 5: INHS Aerial Canada Goose Counts
Mark Twain NWR Complex River Reach**

Fall Migration Month	Canada Geese on Refuge Complex	Total Canada Geese Counted	Percent of Geese Using Refuge Lands
1998 (Wet Fall)			
October	8,390	9,550	88%
November	24,430	25,955	94%
December	26,985	30,550	88 %
1999 (Average Fall Precipitation)			
October	12,105	13,710	88%
November	27,930	31,100	90%
December	25,500	27,620	92%
2000 (Dry Fall)			
October	2,525	2,885	88%
November	25,365	29,455	86%
December*	N/A	N/A	N/A

*Surveys discontinued after first week due to freeze-up.

migration, peak numbers of various species occur at different times. For example, peak numbers of Blue-winged Teal usually occur in mid-September, Northern Pintails in late October, and Mallards in late November (Havera 1999). Mallards, Wood Ducks, Canada Geese and Pintails are some of the earliest migrants heading north in the spring, often passing through central Illinois in late February and early March. Blue-winged Teal and Ruddy Ducks tend to travel north a little later, passing through the northern Mark Twain reaches in early April (Reid et al., 1989). The abundance of migrating waterfowl in the spring is more variable than in the fall. Generally high river levels, flooded fields due to spring rains, and the lack of hunting pressure all encourage spring dispersal of birds into additional areas that are unavailable during the fall (Havera 1999).

The number of ducks that stop in the Refuge reach of the River each year depends on many factors including the number heading north in the spring, the condition of wetlands on the breeding grounds, local fall weather conditions, and local food resources. The Mallard is consistently the most abundant duck migrating through the AEC in the fall. North American breeding population estimates vary widely, but showed a generally declining trend through the early 1990s, rebounding after 1993 to levels not recorded since 1980. Mallard numbers within the AEC have shown similar trends. The lowest number inventoried (45,600) occurred in 1993 when the flood virtually eliminated food resources for waterfowl from large areas of the floodplain, but numbers have rebounded since then. Migration numbers for Pintail and Blue-winged Teal have also shown an up and down pattern. Gadwalls reached record numbers in the INHS survey area in the early 1990s, and Northern Shovelers reached their highest levels in the late 1980s and mid-1990s.

The most numerous diving ducks using the Mississippi River within the AEC are Canvasback, Lesser Scaup, Redhead, and Ring-necked Duck. Pool 19 is a critical migration area for migrating diving ducks in the Midwest due to its large bodies of open water. On Pool 19, fall waterfowl censuses between 1948-84 by F. Bellrose and R. Crompton (INHS data) revealed an average annual peak of 345,000 diving ducks. The composition was 71 percent Lesser Scaup, 18 percent Canvasback, 10 percent Ring-necked, and 1 percent Redhead.

Peak counts of diving ducks on Pool 19 have shown significant declines in recent years. For example, the number of Lesser Scaup declined since a peak of 685,500 in 1969. In 1993, only 2,150 Lesser Scaup were observed from Keokuk to Rock Island, the lowest count since aerial surveys began in 1948. The second lowest number of 16,150 was recorded in 1996. The Lesser Scaup is declining rangewide for reasons that are not clearly understood. It is listed in the FWS Regional Conservation Priorities List as a "species of management concern." Canvasbacks also have been declining in this stretch of the River since 1978, when they reached a peak of 188,150. In 1993, only 8,425 Canvasbacks were observed. (Havera 1999)

Many of the changes in the distribution of migrating diving ducks in the Midwest over the last several decades are attributable to habitat alterations caused by changes in land and water use. Drainage and levee districts drained almost half of the existing bottomland lakes between 1909 and 1922. Increasing flood heights and the deposition of sediments diminished habitat values on the remaining lakes and floodplain. The drought of the late 1980s drastically reduced the number of fingernail clams and aquatic vegetation in Pool 19. Both are important food sources for diving ducks. These resources have recovered only to a small fraction of their early 1980s level.

The most abundant species of nesting duck in the planning area is the Wood Duck. U. S. Fish and Wildlife Service breeding bird survey trends indicate that Wood Ducks have increased an average of 2 percent annually in Illinois from 1966 to 1989, with similar trends throughout the AEC. Wood Ducks and Hooded Mergansers both nest in tree cavities in the floodplain forests of the river corridor. Mallards, Blue-winged Teal, and Canada Geese also nest within the AEC.

Missouri and Illinois are at the northern end of the Mallard wintering grounds and the Mallards are the most common duck seen within the AEC during the Midwinter Waterfowl Inventory. Other species such as Wood Duck, Pintail, and Gadwall may also been seen. The number of ducks in this area in the winter is dependent upon the severity of the weather, abundance of food, and annual variations in the continental populations.

Canada Geese migrating within the AEC consist primarily of the Mississippi Valley Population (MVP), which has increased from an apparent all-time low of 22,000 birds in 1946 to a fall flight estimate of about 1.5 million in the early 1990s. The growth of the MVP is similar to increases in other populations of Canada Geese in North America and is due to better harvest management, remote and less-degraded breeding grounds, and the adaptability of the species. The MVP nests on Hudson and James Bay in Canada and winters in southern Illinois and western Kentucky. Intermingled with the MVP is a large and growing number of Giant Canada Geese of the Mississippi Flyway Resident Population. The Giant Canada Goose population was once thought to be extinct but has now grown to the point of being a nuisance species in many urban areas. Giant Canada Geese are seen year round in the AEC and the species both nests and winters on refuge lands.

The AEC lies east of the main Lesser Snow Goose migration route along the Missouri River. The number of Snow Geese using the UMRS is not only variable from season to season, but during the season as well (see Table 6). Peak numbers often occur the last week of November or the first week of December. Although the data are scattered, it does not appear that concentrations are growing to a level of concern or that they negatively impact refuge food resources. The Complex will continue to monitor Snow Goose numbers and their effect on the UMR corridor in order to develop adaptive management strategies if necessary.

Shorebirds and Marsh Birds

Of the 27 North American shorebird species for which data are available, 16 species have experienced significant population declines in the past two decades.

Table 6: Peak Snow Goose Numbers Using the UMRS[22]

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Average
Peak	6,175	7,300	6,500	16,000	7,900	4,800	9,500	19,220	12,400	7,600	9,740

[22] Data from the Illinois Natural History Survey, Waterfowl Aerial Inventory reports. These snow goose counts include the area from lower Pool 16 through Pool 26 and the Illinois River.

Semipalmated Sandpipers, Short-billed Dowitchers, and Whimbrels, for example, show declines of 30 to 50 percent; numbers of Sanderlings are down 80 percent. Only recently has the importance of interior U.S. habitats to shorebirds become widely understood. Most shorebirds using the interior region (including the AEC) are long-distance migrants that require suitable wetlands where they can stop periodically to replenish their fat reserves. Unlike coastal areas where habitat and food resources are fairly predictable and abundant, resource availability in inland areas is highly dependent on precipitation and hydrology patterns and varies in time and space. Due partly to this unpredictability of habitat, shorebirds migrating through the interior tend to be scattered over larger areas in small numbers at numerous sites, rather than concentrated at a few major staging areas as is common along the Atlantic and Pacific coasts.


Photograph by Jim Rathert

The AEC is included in the Upper Mississippi Valley/ Great Lakes (UMVGL) Regional Shorebird Conservation Plan, developed in 2000 as a component of the North American Bird Conservation Initiative. The purpose of the plan is to conserve shorebirds in the region through a combination of habitat protection, restoration, and monitoring; population monitoring; research; and education/outreach. Species of concern were selected for the region by considering global abundance and distribution, population trends, and relative importance of the UMVGL region to the species. Species of high regional concern in the plan include Short-billed Dowitcher, Greater Yellowlegs, and Wilson's Phalarope.

As with waterfowl, the timing of peak migration varies between species and regions. Composition of species in stopover areas can also differ between spring and fall since some species, such as White-rumped Sandpiper, migrate through the Midwest in the spring and through the Atlantic coast in the fall. Generally, shorebirds begin spring migration through the southern reaches of the AEC by late February, with Killdeer and Common Snipe leading the way northward. Lesser and Greater Yellowlegs also are early migrants, being observed by early-mid March. Spring migration continues into May with Semipalmated Sandpipers, Least Sandpipers and Solitary Sandpipers. The return trip to wintering grounds begins by early-mid July and continues through August and into September. Common Snipe, Pectoral Sandpipers, Dunlins and Western Sandpipers have been observed as late as November and December at Mingo NWR, about 60 air miles southwest of Wilkinson Island Division (Reid et al., 1983).

The Upper Mississippi River is an important nesting and feeding area for Great Blue Herons and Great Egrets because the extensive bottomland forests and diverse aquatic areas provide suitable nesting and foraging habitat. The number of nesting colonies for both species in the AEC declined during the 1970s. Possible causes for the declines include poor water quality, loss of nesting trees and foraging areas, and contaminants. However, the INHS has found an increase in heron and egret rookeries on the River in Illinois since surveys began in 1983. Herons increased from 2,111 nests in 21 colonies in 1987 to 5,045 nests in 20 colonies in 1991. Active egret nests also increased from 351 nests in 14 colonies in 1987 to 1,099 nests in 18 colonies in 1991. Both occur mostly in tall living cottonwood and sycamore trees on River islands. Managed wetlands on Clarence

Cannon NWR have recorded up to 900 individuals of both species after summer drawdowns that concentrated prey items.

Killdeer, Woodcock, Snipe, Moorhen, Coot, Sora and King Rails, Least and American Bitterns, Snowy and Cattle Egrets, Green Herons, and Yellow-crowned Night Herons also have been reported nesting on Complex lands. Clarence Cannon NWR is one of the few sites in Missouri where the state-endangered King Rail is known to nest. In 1999, eight different King Rail broods were seen on the Refuge.

Songbirds

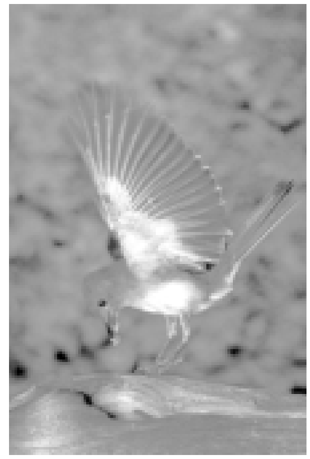
Habitat-specific data on the occurrence, relative abundance, and breeding success of songbird species are not yet available for most areas along the Mississippi River. The Breeding Bird Survey is the only long-term data set for assessing population trends of migratory songbirds as well as certain other migratory birds and residents. Estimating breeding trends specific to the River is difficult because many survey routes exclude the Mississippi River floodplain. There is also little site-specific data concerning songbird use of the river corridor during migration.

However, some trends have been detected from Breeding Bird Survey data obtained within Physiographic Stratum 17. This stratum lies along the UMR, primarily north of the AEC, but also includes large areas removed from the River. Within this stratum, 35 of the 119 species showed significant Breeding Bird Survey trends during 1966-94. Sixty percent of these significant trends were positive, indicating increasing populations, and 40 percent were negative, indicating decreasing populations. These data were similar to continental trends. Songbirds showing increasing trends in the UMR stratum included Rose-Breasted Grosbeak, Cedar Waxwing, Yellow-throated Vireo, Blue-winged Warbler, and American Redstart. Species with decreasing trends included Bobolink, Western Meadowlark, Grasshopper Sparrow, Bell's Vireo, and Marsh Wren.

Although no comprehensive songbird monitoring program has been implemented on the Complex yet, several small-scale surveys have been done in recent years. Most point counts were run only a few years and protocols varied somewhat from study to study, but all of the surveys indicate use of a wide variety of Complex habitats by songbirds. Some baseline point count data was collected at Horseshoe Bend (Port Louisa NWR) in 1995, in forest and grassland areas. Spring migration was well-advanced by the time the survey was initiated, so some species already may have passed through. And this was before large-scale habitat improvements were completed at the Division. Nonetheless, more than 120 bird species were noted, including seven flycatcher species, 15 species of sparrows, and 18 species of warblers.

In 1992, a breeding bird survey was conducted in the mature forest habitat of Long Island Division (Great River NWR). Five routes were run four times each during June. A total of 76 bird species were recorded during the study. Not surprisingly, most were associated with forest habitats. Similar surveys were conducted in 1994 and 1995 using slightly different methodology. Many hard mast trees had died and understory was reduced due to the 1993 flood. A total of 55 and 60 species, respectively, were identified including Cerulean and Prothonotary Warblers, Acadian and Great Crested Flycatchers, and Yellow-billed Cuckoo. These five species were ranked by the Midwest Working Group of

Partners in Flight as neotropical migratory bird species of high management concern (based on Thompson et al. 1993).


File Photo

In June 1997, point counts were conducted on Harlow Island and Wilkinson Island (Middle Mississippi River NWR). Fields had been left idle for several years and many areas were already showing signs of converting to early successional forest. There were also some mature forest stands within the survey areas. Each point was surveyed only once, but 35 and 44 species were noted respectively, including Red-eyed, White-eyed, and Warbling Vireo; Yellow-breasted Chat; Yellow-billed Cuckoo; and Prothonotary and Kentucky Warblers.

Point count surveys were initiated at Big Timber in 1992 and expanded to include Keithsburg in 1993 (Port Louisa NWR), with data collected from both divisions through 1995. A total of 132 bird species were observed at Big Timber, including 60 neotropical migrant species. Keithsburg Division surveys yielded 134 species, with up to 53 neotropical migrants observed, including 22 warbler species and six vireo species.

Two Cerulean Warblers were detected on Delair (Great River NWR) in 1993 as part of the Cerulean Warbler Atlas Project developed by Cornell Lab of Ornithology. The project is designed to determine the status, habitat, and area requirements of the cerulean warbler. The Delair point counts were repeated in 1999. Thirty-one species were heard or seen during the survey, but no Cerulean Warblers were detected.

Raptors
Red-shouldered Hawks are listed as endangered in Iowa and Illinois, rare in Missouri, threatened in Wisconsin, and of special concern in Minnesota. These populations are estimated to be down 90 percent from their pre-settlement historic numbers. The breakup of contiguous forest into small blocks has created habitat more suitable to the aggressive Great Horned Owl and the Red-tailed Hawk, the Red-shouldered Hawk's closest competitor.

Red-shouldered Hawks require relatively large tracts (300 acres or more) of mature floodplain or riparian forests as nesting habitat. Forest structure is important since Red-shouldered Hawks usually select tracts with a well-developed canopy and an open sub-canopy for their nesting sites. Floodplain forests on the edge of the River valley, adjacent to upland or valley slope forests have the highest rate of occupancy. This combination of upland and lowland forest habitat provides a diversity of prey and hunting opportunities, especially during high water.

Red-shouldered Hawk ecology has been studied along the Upper Mississippi River since 1983 by Jon Stravers (National Audubon Society). Survey sites vary from year to year but have been primarily north of the AEC in the McGregor/Dubuque/Bellevue area and in Milan Bottoms, just south of the Quad Cities. Thirty-two breeding territories were confirmed in 1992, and 37 territories were confirmed in 1993. Six sites are currently active between the Quad Cities and Keokuk. Most sites have had a good rate of re-occupation, but a few have been lost, mostly due to large-scale timber harvest on private land. Reproductive success varies somewhat between years, but has been steady over the long-term

(Jon Stravers, pers. communication). Nesting sites that have been occupied year after year usually have had little or no disturbance or logging in the last 40 years or more.

Fish

There are at least 156 species of fish present in the mainstem Mississippi River. About 50 species are common or abundant in certain pools or reaches. Gizzard shad, common carp, and emerald shiner are the three most common species found River-wide. Although the UMR still hosts most of the species that were present historically, the relative abundance and distribution of some species has changed dramatically in the last 100 years. Some of these changes are attributable to events such as the introduction of the common carp, flood protection projects, and construction of the Keokuk, Iowa, hydroelectric dam in 1913 and subsequent locks and dams in the 1930s.

Navigation dams create conditions favorable to many centrarchid species such as bluegill, bass, and crappie, but at the expense of species preferring rapids and swift water conditions such as sturgeon, paddlefish, and blue sucker. The dams also restrict the movement of fish between pools. Rock dikes, constructed to direct water into the navigation channel, create localized fish benefits, but sacrifice habitat diversity system-wide.

In the Upper Mississippi River, the catch of sport fishes has been dominated by bluegills and crappies. Other sport fishes, in approximate order of importance, include white bass, freshwater drum, sauger, channel catfish, yellow perch, walleye, and largemouth bass. The commercial harvest is dominated by four groups: common carp, buffalos, catfishes, and freshwater drum. The abundance of several species in the catch has changed greatly within the last century. The common carp has increased the most and has ranked first among species in the commercial catch for decades. The grass carp first appeared in Pool 25 in 1975 and has since expanded upstream to Pool 5A. A decline in the harvest of buffalo fishes coincided with the increase of common carp. Invasions of these exotic species (e.g. common, grass, bighead, and black carp) constitute a major threat to native fish species.

Long Term Resource Monitoring Program (LTRMP) data suggest that main channel populations of species such as sauger, walleye, channel catfish, and freshwater drum are steady or increasing. Channel catfish in particular have shown significant increases in abundance since the 1970s. Backwater species such as bluegill have shown wide annual fluctuations in abundance, likely due to variable factors such as water level fluctuation and abundance of aquatic vegetation.

The paddlefish was formerly abundant over much of the Mississippi Valley but has undergone a drastic decline since 1900 due to over harvest and destruction of habitat. Under natural conditions, large free-flowing rivers of the Mississippi Valley provided ideal habitat, with their oxbows and backwaters for feeding and extensive gravel bars for spawning. But channelization, levees, and drainage of bottomland lakes have eliminated much of the feeding habitat (Pflieger 1997). Swan Lake (Two Rivers NWR) has been identified as providing spring feeding habitat for paddlefish. Since 1995, more than 250 paddlefish have been tagged and released in the lake as part of a Mississippi Interstate Cooperative Resource Association (MICRA) study to assess the status of paddlefish stocks.

The shovelnose sturgeon inhabits the bottom of open channels of large rivers, often in areas of swift current and sand or gravel bottom. The shovelnose is the most abundant sturgeon in the Mississippi and Missouri rivers but has declined greatly since 1900. In recent years, the catch of sturgeon in Missouri has averaged only about 9,000 pounds annually, compared to more than 150,000 pounds reported in 1899. In common with many big-river fishes, the shovelnose sturgeon can migrate long distances. One fish tagged in the Mississippi near the mouth of the Ohio River in 1978 was caught 7 years later in the Wabash River in Indiana (Pflieger 1997).

The lake sturgeon primarily inhabits areas with firm, silt-free bottoms of sand, gravel, and rock. Before 1900, lake sturgeon was a common fish in the AEC. Missouri fisherman harvested 50,000 pounds from the Mississippi and Missouri Rivers in 1894. By 1908, the lake sturgeon was rarely taken. In 1984, the Missouri Department of Conservation began releasing hatchery-reared fish into several places including the Missouri River and Mississippi River Pool 24. Small lake sturgeon from these stockings have been reported by fishermen from several localities along the rivers.

Thirty-four UMR fish species exhibit seasonal movements to spawning areas, over-wintering locations, or other habitats. The effects of Mississippi River dams on fish movement were first raised in the early 1900s when the Keokuk hydroelectric dam (which now forms Pool 19) was constructed. Keokuk Dam presents an almost insurmountable obstacle to fish passage. Carlander (1954) described the changes in the fishery after dam construction:

> "There was evidence that the dam was a barrier to extensive upstream migration of paddlefish, American eel, skipjack [herring], Ohio shad, buffalo, shortnose gar, freshwater drum, carp, shovelnose sturgeon, and three species of catfishes...The only fish likely to have their spawning interfered with were the skipjack, Ohio shad, and the blue sucker...this interference was of great importance in the case of the skipjack, because it is the host for the larval form of the important ebony shell mussel, so valuable in the button industry (Coker, 1930). In the 1930's and 1940s there apparently were fewer paddlefish, no skipjacks, probably fewer blue catfish and fewer American eels above Keokuk Dam than prior to 1910...The blue sucker was at one time a fairly important commercial species in swift parts of the river...By 1926 it had virtually disappeared...However there were other factors which changed after the dam was built and these may also have influenced the decline of these species." (Nelson et al.)

The degree to which UMR navigation dams impede fish movement has been unknown for decades. An analysis of 126 fish movement studies indicates that the dams are undoubtedly impeding movement of both native and exotic species between navigation pools. What is yet to be determined is how significant this impediment is to fish populations. Lateral floodplain connectivity is also important for movement of fishes to fulfill life history requirements; but in many reaches, levees isolate one half or more of the floodplain from the mainstem river (see Floodplain Management Goal discussion).

In the Middle Mississippi River (the unimpounded UMR below St. Louis), wing dikes and revetments have closed off side channels at lower flows and resulted in a narrower, deeper, and swifter river. Upstream reservoirs on the Missouri

River have reduced the high natural turbidity and sediment load in the Middle Mississippi River. Populations of at least five fish species (pallid sturgeon, sturgeon chub, sicklefin chub, flathead chub, and western silvery minnow) adapted for life in turbid plains rivers have fallen in numbers to the point that long-term species survival is in doubt (Pflieger 1997). All five species are listed in the USFWS Region 3 list of Resource Conservation Priorities. The pallid sturgeon is a federally-listed endangered species (See Endangered Species section). The sturgeon chub and sicklefin chub were candidates for listing, but a status review completed in 2001 indicates that populations are more abundant and better distributed than previously believed.

The sturgeon chub is confined to open channels where it lives in a strong current over a bottom of sand and fine gravel. Its historic range includes the Yellowstone River, the Missouri River, and the Mississippi River south of the Missouri River confluence. It is now estimated that the species occupies about 55 percent of its historic range, including a viable population in the Middle Mississippi River.

The sicklefin chub, like the sturgeon chub, is adapted for life in large, turbid rivers with strong current and a bottom of sand or fine gravel. Its historic range includes the Lower Yellowstone River, the Missouri River, and the Mississippi River south of the Missouri River confluence. Today the species is estimated to occupy about 54 percent of its historic range. Data collected by the Missouri Department of Conservation since 1997 indicate that a viable population of sicklefin chub is present in the Middle Mississippi River.

The flathead chub is found in turbid waters with swift current and a bottom composed of sand and fine gravel. The flathead chub was the most abundant small fish collected in the Middle Mississippi River in the 1940s. By the middle 1960s, it had begun a precipitous decline and by the 1980s it comprised less than 0.1 percent of small fishes from the Middle Mississippi. The decline coincided with the construction of six large reservoirs on the upper Missouri River that altered the natural flow regime and decreased the water turbidity.

The western silvery minnow is generally found in backwaters and pools of large streams. It was formerly common behind wing dikes and revetments but has undergone a drastic decline in recent decades. The historic distribution of the plains minnow was similar to the western silvery minnow and, like that species, has undergone a dramatic decline in recent decades. Although they both occur at the same localities, the plains minnow prefers sandy bottoms with some current while the western silvery minnow is more common in protected areas with little current and a silt bottom.

Freshwater Mussels

Mussels serve as good indicators of ecosystem health because they are relatively long-lived and depend on good water quality and habitat. Eggs are fertilized by sperm released into the water by the males. The females expel their embryos into the water for attachment to an intermediate fish host. After further development, the young mussels drop off the fish and, if they land in suitable habitat, can become adults. Freshwater mussels are typically found buried in the substrate in beds containing several different species with similar habitat requirements Most of these species require flowing water and coarse gravelly substrates, although some survive well in silty lake-like conditions in backwaters.

Mussel populations in the UMR are declining in both abundance and diversity. In the main stem of the UMR, 51 species of freshwater mussels have been recorded historically, but only 44 species have been documented in surveys conducted within the past 35 years. Many of the absent species were considered infrequent inhabitants of the UMRS mainstem by biologists in the early 20th century, but were more commonly found in the tributaries of the UMRS. Upstream from lock and dam 19, mussel composition changed after 1913 in part because some fishes that are obligatory hosts for mussels could not migrate past the dam. Navigation dams built in the 1930s also affected mussels by changing the character of the River. For instance, the three-ridge mussel is now the most abundant species in the UMRS. The ebony shell (formerly comprising 80 percent of the mussel fauna) and elephant's ear almost disappeared because populations of their primary fish host (skipjack herring) declined sharply. Populations of other species such as the washboard, mapleleaf, flat floater, and lilliput mussels have increased in pooled portions of the River.

Some mussel species in the UMR are declining due to sedimentation, the introduction of zebra mussels, and poor water quality. Heavy commercial harvesting formerly for the pearl button industry, and more recently to supply raw shells for the cultured pearl industry in Japan, have also been detrimental to mussel populations. Between 1982 and 1986, massive die-offs of mussels occurred in the UMR, but the exact cause was never identified. Little is known about the biology and population dynamics of mussels or to what degree commercial exploitation or other human-induced factors have affected these animals.

Three species historically present in the AEC are currently federally listed as endangered: (Higgins eye pearlymussel, fat pocketbook, and winged mapleleaf. The five UMRS border states list many other mussel species as threatened or endangered (see Appendix B). Interagency management recommendations concerning the protection of mussel populations include establishing reaches of the UMR as mussel sanctuaries, developing population models to guide and assist the management of mussels, and monitoring zebra mussel densities and impacts in the Mississippi River.

Macroinvertebrates

Macroinvertebrates are creatures smaller than freshwater mussels, but large enough to be captured by screens used to filter samples. Macroinvertebrates (such as mayflies, midges, worms, and fingernail clams) are integral to the River's food chain and are important water quality indicators. They digest organic material and recycle nutrients. They feed on aquatic vegetation, algae and detritus, converting energy in lower levels of the food chain into a form more usable by vertebrate river fauna. Macroinvertebrates provide an important food source for waterfowl, other waterbirds, and fish.

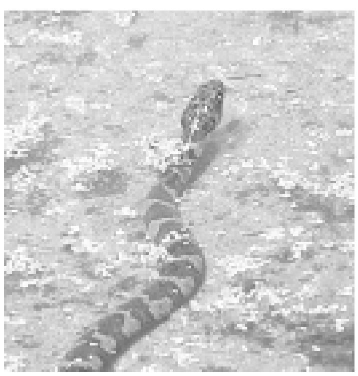
Fingernail clams are important to the diet of migratory diving ducks, including Lesser Scaup, Canvasback, Ring-necked Duck, and Common Goldeneye, as well as fish. During the 1980s, clam densities were found to have dramatically declined in samples collected in many UMR pools. Densities in Pool 19 averaged 30,000 per square meter in 1985 and decreased to zero in 1990. The observed declines of fingernail clams, as well as their slow rate of recolonization, were seemingly caused by the uninhabitability of bottom sediments – perhaps due to the presence of one or more toxic substances (Wiener et al., 1998).

Since 1992, benthic (bottom-dwelling) invertebrates, such as fingernail clams and burrowing mayflies, have been sampled in Pools 4, 8, 13, and 26, and in an open-river reach near Cape Girardeau, Missouri. Fingernail clam densities were 0-2,500 per square meter. Mayfly densities were 0-237 per square meter. Most samples contained no mayflies or fingernail clams, and low densities were common. Densities of both organisms were consistently highest in Pool 13 and lowest in Pool 26 and the open reach of river. Densities of both mayflies and clams also varied among habitat types; areas classified as contiguous backwater, impounded, and tributary delta lake had much higher mean densities than main channel border and side-channel habitats. This pattern was anticipated, as the instability and sandy content of channel substrates make them a less-suitable habitat for most macroinvertebrate species than the muddier substrates of non-channel areas.

Studies of macroinvertebrate communities other than bottom dwellers are limited. Areas containing wetland plants typically support more predaceous species (e.g. dragonfly nymphs, beetles, etc.) than do open water sediment areas. The macroinvertebrate community found above the river bottom consists of animals that are free-swimming (e.g. water boatmen, beetles), those that float in the water column (e.g. zooplankton), or live on the water surface (e.g. whirligig beetles, water striders). This community also is generally more abundant in aquatic plant beds and flooded terrestrial vegetation. They provide important waterfowl food and also are important for fish populations, especially the zooplankton eaten by larval fish (Lubinski and Theiling 1999). Rock-dwelling communities (e.g. caddis flies) in the UMRS now are confined mostly to wing dams, revetted banks, and other channel training structures made of rock. In the unmodified river they would have been found on woody debris, on boulders in rapids, and on cobble sediments of the riverbed.

Reptiles and Amphibians

Amphibian population declines and malformations are occurring worldwide and many studies are under way to determine extent, causes, and solutions. In response to these concerns, Port Louisa NWR, Two Rivers NWR and Great River NWR (along with 36 other refuges) participated in a region-wide monitoring effort in the summer of 1997. On Port Louisa NWR, 54 leopard frogs were captured with no observed malformations. On Two Rivers NWR, 20 malformed leopard frogs were observed out of 217 captured (9.2 percent), while Great River NWR had 13 malformations out of 217 leopard frogs (5.9 percent). Some of these malformations may have been due to predation, or injury during capture. The study was repeated at Two Rivers NWR and Great River NWR in 2000, with 5 out of 147 frogs (3.4 percent) having malformations at Two Rivers, and 1 out of 135 (0.7 percent) having malformations at Great River. Malformations consisted primarily of missing limbs or parts of limbs, although one club foot and several missing eyes were also noted. The study will continue for at least one more year.



Photograph by Jim Rathert

Amphibian call count surveys have been conducted on Big Timber and Keithsburg Divisions of Port Louisa NWR since 1993. Ten species have been heard including the gray treefrog, western chorus frog, Copes treefrog, Fowler's toad, and Woodhouse's toad (a species normally found in western Iowa). Similar surveys have been done on Clarence Cannon (Great River NWR) since 1995 in cooperation with Missouri DNR. Noteworthy was the presence of a green treefrog in 1996, a species not previously recorded on the Refuge.

There is concern about declining female turtle populations (primarily red-eared slider) in the Calhoun Division area. Male turtles rarely leave the water while females must do so to lay their eggs. According to Dr. John Tucker (Illinois Natural History Survey, LTRMP), the majority of turtles taken under Illinois fishing licenses are by hand and are, therefore, female. A Special Use Permit has been issued to him to collect gravid females and release the hatchlings back onto the Refuge.

The copperbelly watersnake (*Nerodia erythrogaster neglecta*) was recently confirmed in Louisa County, Iowa, on Port Louisa NWR and adjacent state-managed land. Copperbelly habitat generally consists of wetlands and bottom-land forests, although they sometimes hibernate in upland areas. They are often seen near shallow wetland edges in woodlands where buttonbush is the preferred vegetation type. The copperbelly is a federally-listed threatened species in Michigan, Indiana, and Ohio. It was not listed in Illinois and Kentucky because of protections provided by a Conservation Agreement with the mining industry. At the time the Conservation Agreement was established, the Iowa population had not been discovered. Because most of this local population is thought to reside on public land, a Conservation Agreement may provide sufficient protection, making official listing unnecessary. The Refuge will continue to work with the Ecological Services office on the monitoring and management of this species.

The eastern massasauga rattlesnake (*Sistrurus catenatus catenatus*) is a candidate for listing under the federal Endangered Species Act and is listed as endangered, threatened, or species of concern in all states where it is currently found. Massasaugas show a strong affinity for wetlands, but also utilize upland habitats during part of the year. It appears that structural characteristics of a site are more important than vegetation type. Suitable habitat includes three components: 1) open, sunny areas intermixed with shaded areas for thermoregulation, 2) presence of the water table near the surface for hibernation, and 3) variable elevations between adjoining lowland and upland areas. The range of the massasauga includes western New York and southern Ontario to southern Iowa and northeastern Missouri, but within this range, the number of populations has steadily declined. Today, the eastern massasauga is generally found only in small, isolated remnant populations due to habitat loss and indiscriminate killing. There are no known populations remaining within the AEC.

Endangered Species

Indiana Bat (*Myotis sodalis*)

The Indiana bat is an endangered species that has been found in 27 states throughout much of the eastern United States. The total known population in 1997 was estimated at 353,000, which represents a decline of about 60 percent since population surveys began in the 1960s.

Indiana bats winter in caves or mines that satisfy their highly specific needs for cold (but not freezing) temperatures during hibernation. Stable low temperatures allow the bats to maintain a low rate of metabolism and conserve fat reserves through the winter. The fact that Indiana bats form large aggregations in only a small percentage of known caves suggests that very few caves meet their requirements.

During the summer, Indiana bats roost in trees and forage for insects in or near floodplain and upland forests, including the Area of Ecological Concern. The Service recommends that no tree clearing occur between April 1 and September 30 within the preferred summer range of the Indiana bat, unless mist-netting indicates that the species is not present in the area. The Indiana bat prefers standing dead trees with loose bark and enough space to roost between the bark and the trunk. Therefore, to be suitable summer habitat, a forest needs to provide a continual supply of dead trees. Indiana bat roost trees typically are located within 500 meters of a stream or river. Indiana bats feed exclusively on flying insects. Mating occurs in the fall at the hibernation caves. Females usually produce only one offspring per year in June. Limited observations indicate that birth and development occur in small, widely scattered maternity colonies consisting of 25 or so females and their young.

The short-term objective of the Indiana Bat Revised Recovery Plan (Draft 1999) is to halt and reverse the continued decline of the Indiana bat. The long-term objective is the eventual de-listing of the species. To date, conservation efforts have concentrated on protection of winter habitat along with some life history research. A number of hibernation caves have been protected, but these measures have not produced the desired result of recovery for this species.

Not all of the causes of Indiana bat population declines have been determined. Although several known factors have caused declines in the past (vandalism, gates on cave entrances, natural hazards such as flooding and freezing), they do not appear to account for the current decline. Potential, but unproven, causes include changes in the microclimate of specific caves, chemical contamination, and land use practices (such as forest fragmentation, fire suppression, loss of plant community diversity).

Until we better understand the factors that are contributing to the decline of the Indiana bat, we cannot accurately assess whether the loss of summer habitat is limiting to the species. Increased knowledge of the species' ecology during the summer and migration seasons is needed in order to effectively conserve and restore Indiana bat populations.

Pallid Sturgeon (*Scaphirynchus albus*)

The pallid sturgeon is primarily a bottom-dwelling species, preferring turbid water with a strong current and firm substrate, along sand bars, and behind wing dikes with deeply scoured trenches. Its range includes the Missouri River, the middle and lower portions of the Mississippi River, and some portions of their major tributaries. Although the pallid sturgeon has a large range, catch records are extremely rare. Little is known of the basic biology, life history, and habitat utilization of this species. In addition, the pallid sturgeon hybridizes with the more common shovelnose sturgeon, making identification difficult.

The pallid sturgeon has a unique prehistoric-like appearance with a flattened snout, long slender tail and rows of bony plates instead of scales. The mouth is positioned under the snout for sucking small fish and invertebrates from the river bottom. Pallid sturgeon can weigh up to 80 pounds and reach lengths of 6 feet.

Modification of habitat has been a major factor in the decline of the species. Human alteration of the River has blocked fish movement, destroyed or altered spawning areas, reduced turbidity, and changed the natural hydrograph. Over-fishing, pollution, and hybridization also have probably contributed to the population decline. The pallid sturgeon was federally listed as endangered in September 1990.

Pallid sturgeon are being spawned and reared successfully at several fish hatcheries for restocking in suitable habitat. In addition, spawning of pallid sturgeon in the wild had never been documented until July 1998 when a young-of-the-year pallid sturgeon measuring 79 mm was collected in an experimental trawl near Cape Girardeau, Missouri.

The recovery objective (Pallid Sturgeon Recovery Plan, Dryer and Sandvol, 1993) is to delist the species through protection and habitat restoration activities by 2040. Achievement of this objective will require a better understanding of the basic biological characteristics and habitat needs of the species. Research projects are currently under way throughout its range. For instance, biologists at Southern Illinois University (SIU) in Carbondale, Illinois are studying habitat use and movements of pallid sturgeon in the Middle Mississippi River. In this effort wild fish caught by researchers and commercial anglers are surgically implanted with sonic transmitters and re-released into the River. Ten hatchery-reared pallid sturgeon also were implanted with transmitters and released in 1997. A total of 157 relocations of the study fish were made between November 1995 and September 1998. Average home range was 21.2 miles and the study fish appeared to move generally upstream during the late summer and fall, and slowly downstream during the winter. Study fish were found most often in the main channel, the main channel border, and between wing dams.

A USFWS Biological Opinion released in May 2000 determined that the continued existence of the pallid sturgeon would be jeopardized by continued operation and maintenance of the 9-foot navigation project. The Opinion states that the navigation project will continue to disrupt and alter dynamic natural river processes (e.g. channel meandering, erosion, deposition) leaving little opportunity for the establishment of important aquatic habitats. "Reasonable and prudent" alternatives recommended to the COE in the Biological Opinion include:

(1) Conduct a Middle Mississippi River pallid sturgeon habitat study.

(2) Facilitate development of a pallid sturgeon conservation and restoration plan.

(3) Implement a long-term Middle Mississippi River aquatic habitat restoration program.

Higgins' Eye Pearlymussel (*Lampsilis higginsi*)

The Higgins' eye pearlymussel, *(Lampsilis higginsi)* was historically found in the Upper Mississippi River as far north as the southern half of Minnesota and Wisconsin, ranging south to Iowa, Missouri and Illinois. Currently the only known population in the AEC is within the Rock River, near Rock Island, Illinois. The Higgins' eye prefers sand or gravel substrates in fast currents of larger rivers. This mussel was never abundant, and where it has been found only comprised a small percentage of the mussel population. The site near Rock Island is one of 10 sites within its range determined to be essential to the survival of the species.

A USFWS Biological Opinion (May 2000) determined that the continued existence of the Higgins' eye pearly mussel would be jeopardized by continued operation and maintenance of the 9-foot navigation project. The barges using the navigation channel facilitate upstream transport of zebra mussels. Zebra mussels attach to native mussels in such large numbers that infested mussels cannot breathe, feed, burrow, or move. A "reasonable and prudent" alternative recommended by FWS is for the COE to (1) develop a Higgins' Eye Pearlymussel Relocation Action Plan and (2) to conduct a reconnaissance study on the feasibility of zebra mussel control in the UMR.

Fat Pocketbook Mussel (*Potamilus capax*)

The fat pocketbook mussel was Federally listed as endangered in 1976. Its historic range included Iowa, Illinois, Arkansas, Kentucky, Missouri, Mississippi, and Ohio. This mussel prefers large rivers in slow-flowing water with a mud, sand or fine gravel substrate. Its fish host species is unknown. The fat pocketbook is now thought to be extirpated from its entire range, including the AEC.

Winged Mapleleaf Mussel (*Quadrula fragosa*)

The winged mapleleaf was historically found in 11 midwestern states including the AEC, but siltation, pollution, and dams have destroyed its habitat. Today *Quadrula fragosa* is probably extirpated from its historic range except for one remnant population in the St. Croix River between Minnesota and Wisconsin. The winged mapleleaf was Federally listed as endangered in June 1991. Recovery criteria include maintaining the St. Croix population and re-establishing four additional populations within its historic range.

Bald Eagle (*Haliaeetus leucocephalus*)

Historically, there may have been as many as 100,000 nesting Bald Eagles in the conterminous United States when the bird was adopted as our national symbol in 1782. But, by the early 1900s, Bald Eagle numbers were declining nationwide because of habitat loss and illegal shooting. The Bald and Golden Eagle Protection Act passed in 1940 prohibited killing or selling Bald Eagles and their parts. However, the populations continued to decline due to the pesticide DDT. By 1963, only 417 nesting pairs were found in the lower 48 states. In 1967, the Bald Eagle was listed as endangered under the Endangered Species Preservation Act. Following the passage of the Endangered Species Act in 1973, the bird was listed as endangered or threatened throughout the lower 48 states. Numbers have steadily increased since DDT was banned in the U.S. in 1972. In 1995, the FWS announced that Bald Eagles in the lower 48 states had recovered to the point that those populations previously considered endangered had been down-listed to threatened status. Populations continued to increase. Today, there are more than 5,700 nesting Bald Eagle pairs. At this writing the FWS has proposed to completely remove it from the endangered species list. If de-listed, the species will still be protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

Bald Eagles are regularly seen using refuges within the Mark Twain NWR Complex during migration for resting, feeding, and, more recently, nesting. Mature trees are a key component for eagle habitat along the River corridor, for both roosting and nesting. During fall migration eagles take advantage of large trees near dependable fishing spots. In the winter, particularly when ice has formed on most of the River, the tailwater areas just below each dam provide prime fishing locations for eagles. Those dams, which also include perching trees along the downstream side, are great places for the public to view large numbers of eagles from relatively close locations. Winter eagle watching is a popular "Watchable Wildlife" opportunity along the AEC.

Numbers of breeding Bald Eagles along the Upper Mississippi River have increased from two to five pairs in the 1970s to 43-44 pairs in 1993 and 1994. Productivity per nest varied little between 1986 and 1993, with 0.95 to 1.5 young per nest. There are presently 19 known active eagle nests within the Mark Twain Complex AEC (Pools 15-26 and open river). There are also five active eagle nests located in the Alton Pool on the Illinois River. Eagles nest on several refuge divisions, but the most consistent area has been Clarence Cannon NWR where approximately 20 young have been produced in the last 10 years. The Upper Mississippi River is a major migration route and wintering area for Bald Eagles. More than 150 roosting and feeding areas for Bald Eagles have been reported within the Mark Twain Complex AEC.

Interior Least Tern (*Sterna antIlarum athalassos*)

The interior population of the Least Tern currently nests in the Mississippi and Rio Grande River basins from Montana south to Texas, and from eastern New Mexico and Colorado to Indiana and Louisiana. Loss of sandbar habitat due to dams, river channelization, and water level changes has caused a decline in interior Least Tern populations. Undisturbed sandbars are critical for successful nesting. Predation, flooding and recreational activities on sandbars can cause nest disturbance and abandonment. The interior Least Tern was Federally listed as endangered in May 1985.

Currently, within the AEC, the interior Least Tern nests only in the Middle Mississippi, south of RM 80. Seemingly suitable sandbar habitat north of RM 80 may be unused due to high spring water levels that inundate the sandbars. The population has been increasing on the Middle Miss, but it appears that local productivity is not great enough to support these increases. It may merit investigation whether some of these birds are coastal subspecies migrating inland (Kirsch 1999). Interior Least Tern management techniques include the creation of new nesting habitat through the use of dredged material and/or channel training structure modifications, removal of vegetation from existing sandbars, modification of water level management, and restrictions of public use on nesting beaches.

Decurrent False Aster (*Boltonia decurrens*)

The decurrent false aster is a Federally listed threatened species that historically ranged along a 248-mile stretch of the Illinois River and Mississippi River floodplains between LaSalle, Illinois, and St. Louis, Missouri. Its natural habitat included wet prairies, shallow marshes, and the shores of rivers, creeks, and lakes.

Although *Boltonia* population levels vary somewhat from year to year, the overall number of naturally occurring populations continues to decline (Smith et al., 1998). The draining of marshes, lakes, and wet prairies for conversion to cropland characterizes the habitat destruction and modification believed to be the main reasons for the decline of *Boltonia*. The construction of dams, locks, and levees along the River has altered the natural hydrologic cycle, often causing either a lack of flooding or prolonged inundation. Although the seeds of *Boltonia* are apparently adapted for water dispersal, the levee systems provide a barrier to dispersal except during major floods when the levees are overtopped (Smith and Keevin, 1998). In addition, intensive agriculture has increased soil erosion and resulted in heavy siltation in flooded areas. A study conducted by Smith and Keevin (1998) indicated that seeds covered with as little as 0.5 centimeters of sediment did not germinate.

Boltonia can be distinguished from other asters by its decurrent leaves and absence of rhizomes. The wing-like appendages of the leaves give the stem of *Boltonia* a slightly ruffled look. The flower heads have a yellow disk surrounded by white to pale violet rays. The species can reach more than 2 meters in height. *Boltonia* flowers between August and November. The seeds usually germinate in the fall and then overwinter as vegetative rosettes. Populations also can be maintained by the vegetative production of basal rosettes. In fact, few seedlings are found in established populations; most regeneration occurs vegetatively which can give *Boltonia* populations a clumped appearance.

Boltonia is extremely tolerant of long periods of inundation and the flood-related deaths of less tolerant species may be important in maintaining its presence in the floodplain. Although *Boltonia* can establish and grow quickly immediately following a flood disturbance, it will be replaced within 3 to 5 years by faster-growing species unless another disturbance occurs. Shade created by competing species prevents seed germination, slows plant growth, and reduces seed production.

Before the flood of 1993, *Boltonia* populations had been declining for several years. In 1993, only four of the existing populations produced any flowering plants. However, in 1994, two new populations were discovered and existing populations increased dramatically in size. Currently, there are approximately 20 disjunct populations that range from Bureau County, Illinois, to St. Clair County, Illinois, and west to St. Charles County, Missouri (Smith, pers. comm.).

One known population is located on the Gilbert Lake Division of Two Rivers NWR. Although the Gilbert Lake population was virtually eliminated by the 1993 flood, it rebounded with the establishment of thousands of new seedlings in 1994 (Smith et al., 1998) and a current population of approximately 250 individuals. The Refuge currently controls encroaching willow by mowing and disking as needed. A step-down management plan will be developed in consultation with the Rock Island Ecological Services office.

Habitat [23]

The Mississippi River, together with its floodplain, provides important habitat for fish and wildlife and includes the largest continuous system of wetlands in North America. The River corridor contains a diverse array of wetland, open-water, and terrestrial habitats, but human activities have greatly altered this river ecosystem for commercial navigation and other development. Much of the watershed is intensively cultivated and many tributaries deliver substantial amounts of sediment, nutrients, and pesticides.

Throughout the River corridor two of the most historically prevalent, and now highly impacted, habitat types are forest and aquatic vegetation. The impacts of water level fluctuation, sedimentation, and development have been particularly severe south of the Quad Cities.

[23] Much of the material in this section is edited directly from the 1998 USGS Report on the *Status and Trends of the Nation's Biological Resources*, specifically the 'Regional Trends of Biological Resources - Mississippi River' chapter. This section was prepared at the Upper Midwest Environmental Sciences Center, see reference section for complete citation of contributors.

Wetland

Emergent and submersed aquatic plants were present but not abundant in the Upper Mississippi River before the construction of locks and dams in the 1930s flooded thousands of hectares of marsh, bottomland forest, and agricultural areas. The creation of navigation pools abruptly altered the hydrology of the River, and the diversity, abundance, and distribution of aquatic plant species changed markedly in the decades after impoundment. Water levels were unaltered in the upper end of the navigation pools, and these areas remained in the natural condition of deep sloughs and forested islands. In the middle of the pools, shallow flooding of terrestrial areas encouraged the development of marshes. The downstream reaches of the newly created pools were usually too deep for marshes but often supportive of aquatic plants (Havera 1999).

However, new growth of aquatic and wetland plants in the impoundments soon showed signs of deterioration. Water circulation in many backwaters was limited and sedimentation increased, resulting in decreased diversity and abundance of aquatic vegetation. The broad floodplain of the AEC encouraged the establishment of drainage and levee districts for agriculture and the extensive loss of wetlands. Some of this former wetland habitat has been restored in Refuge divisions within the Mark Twain NWR Complex including Louisa, Keithsburg, Clarence Cannon, Delair, and Batchtown. Wetland and aquatic vegetation is almost non-existent in the open river reach.

Most of the wetland vegetation monitoring on the UMR has focused on submersed aquatic species. The abundance of many submersed plants, including wild celery, declined markedly in much of the Upper Mississippi River during the drought of the late 1980s. More than 1,200 acres of submersed vegetation disappeared in the lower half of Pool 19, where plant beds had generally been expanding since the 1960s. In early September 1990, the only submersed vegetation found in the lower half of Pool 19 were small patches of Eurasian watermilfoil.

Most species of submersed plants also decreased in frequency of occurrence during the 1993 flood at monitoring sites in Pools 4, 8, 13, and 26. The decreases were greatest in Pools 13 and 26. In 1994, submersed aquatic plants had recovered to pre-flood frequencies in Pools 8 and 13, but not in Pool 26, where the duration and magnitude of the flood were greatest. Sedimentation, water turbidity, and grazing fish (particularly common carp) may be inhibiting the reestablishment of submersed aquatic plants in some parts of the River.

Relatively little wetland habitat still exists within the AEC compared to the years immediately following lock and dam construction, except within federal or state-managed areas and private duck-hunting clubs. Even less acreage is managed as "sanctuary" for migratory birds. In the non-hunted sanctuary areas, birds can rest and feed with minimal disturbance during that segment of their fall migration. When disturbance causes unnecessary flights, feeding is disrupted and extra energy is expended. To meet these increased energy demands waterfowl must increase foraging time, and if food resources become limited, birds may need to depart the area with less than optimal body weight. Excessive disturbance or hunting pressure also tends to reduce hunting opportunity by stimulating the birds to move through these mid-migration areas sooner than normal weather conditions would otherwise dictate. At the present time, most of the available sanctuary is located within the boundaries of the Mark Twain Complex. A few state areas provide temporary sanctuary to waterfowl by ending shooting hours early, while some private lands are hunted by only a few people, which results in light pressure. The Complex will be evaluating this factor in greater depth in conjunction with the completed Habitat Needs Assessment and will consider sanctuary needs in future public use management designations for the expanded boundary areas included in this plan.

Forest

Floodplain forests in the Upper Mississippi River valley are now confined to a riparian zone a few kilometers wide at most. Agricultural and urban development have been leading causes of the loss of floodplain forests along the Upper Mississippi River. By 1929, farmland and urban areas covered 22 percent of the floodplain, and forest had declined to 29 percent. In 1989, forests covered 14 percent of the overall floodplain and the amount was: 18.9 percent between Minneapolis, Minnesota, and Bellevue, Iowa; 13.5 percent between Bellevue and Alton, Illinois; and 7.3 percent downstream from Alton. In many reaches, especially downstream from Bettendorf, Iowa, most of the forest is on islands. The loss of forests in the Upper Mississippi River valley, although considerable, has been less than that in many other large North American floodplain rivers, such as the Missouri, Illinois, Ohio, and the Lower Mississippi. This is attributed to the acquisition of land for navigation pools and national wildlife and fish refuges, which placed more than 497 square miles of the Upper Mississippi River valley into public trust.

Flooding, erosion, and sedimentation are powerful natural processes that shape floodplain landscapes and affect succession and species composition of forests. However, these hydrologic and geomorphic processes have been constrained by navigation and flood-protection structures in the Upper Mississippi River for several decades. These, and other factors, have resulted in an altered forest composition throughout the Refuge Area of Ecological Concern. Individual forest stands on the UMR floodplain can be dominated by any or a few of several species, including (but not limited to) black willow, eastern cottonwood, sycamore, boxelder, silver maple, river birch, green ash, American elm, hackberry, pin oak, bur oak, and swamp white oak. Silver maple is now the predominant species in all reaches. American elm declined markedly during the 1900s because of Dutch elm disease. Eastern cottonwood, green ash, and oaks have all become less abundant relative to silver maple. For example, forests at the confluence of the Mississippi and Illinois rivers, now dominated by silver maple, were co-dominated by hackberry, elm, pecan, willows, and eastern cottonwood during early European settlement. Floodplain forests along a 50-mile unimpounded reach of the Upper Mississippi starting 13 miles upstream from the mouth of the Ohio River were dominated by eastern cottonwood and sycamore during early settlement but are now dominated by silver maple and willow. The amount of forest in pioneering and transitional successional stages has decreased greatly, and much of the present forest in the UMR floodplain is overly mature.

Extreme flooding during a single growing season can severely disturb forests. This is illustrated by the effects of the Flood of 1993, a year when unusually heavy, persistent rainfall caused extreme flooding that lasted from early spring through much of the growing season along much of the Upper Mississippi River. The Flood of 1993 caused substantial tree mortality in the forests, particularly in lower reaches of the UMR, where the flood persisted the longest. Mortality was positively correlated with flood amplitude and duration, and negatively correlated with tree size. Overall tree mortality in 1994 ranged from 1 percent to 4 percent in Pools 4, 8, and 13 and from 18 percent to 37 percent in Pools 17, 22, 26, and the open river. For saplings, overall mortality rates were higher, ranging from 2 to 9 percent in Pools 4, 8, and 13 and from 48 to 80 percent in Pools 17, 22, 26, and the open river reach between St. Louis and Cairo, Illinois.

The mortality of trees and saplings varied greatly among species. The least flood-tolerant trees were hackberry, Kentucky coffeetree, sugarberry, river birch, and white mulberry. Pin oak, silver maple, American elm, and slippery elm were moderately tolerant, and sycamore, hawthorn, green ash, black willow, swamp white oak, slippery elm, and eastern cottonwood were more tolerant. The effects of the 1993 flood on forests along the UMR are expected to persist for decades.

Grassland

At the time of European settlement, prairie grasses dominated more than 50 percent of Illinois and the state was once nicknamed the "Prairie State." Nearly all of Iowa and about 40 percent of Missouri were once covered with tallgrass prairies. Now, as a result of the intense agriculture now present throughout the Midwest, less than one-tenth of 1 percent of the original tallgrass prairie exists in these states. According to the Habitat Needs Assessment, the extent of grassland fragmentation and conversion are the most extreme changes in many parts of the UMRS. Grassland patch connectivity has been highly reduced agriculture and development. Historic surveys indicated that grasslands and oak savanna once dominated floodplain plant communities throughout the AEC. The following examples demonstrate how grassland habitats have been reduced: Pool 17 – 56 percent pre-settlement to 7 percent contemporary; Pool 22 – 35 percent to 4 percent, Pool 24 – 47 percent to 3 percent and Pools 25/26 – 47 to 6 percent.

Many of the divisions in the Complex contain managed grasslands. The Horseshoe Bend Division has about 250 acres of restored native prairie on the highest elevations and over 2,000 acres managed as grassland and wet meadow containing some non-native species. The Horseshoe Bend Division contains the largest grassland tract on the Complex. Following the Flood of 1993, small patches of native prairie cordgrass began to reappear on several divisions including Louisa, Horseshoe Bend and Clarence Cannon NWR.

Soils

Alluvial soil associations predominate within the Mark Twain Complex management divisions. Alluvium is water-transported sediment that has been deposited along rivers and streams and on stream terraces. The main sources of alluvium are loess, glacial till, and sediment deposited by the Mississippi River when overflowing its main channel. The coarser or larger particles generally are deposited closer to the stream channel or in and along the path of the main current of the overflowing stream. The finer particles are deposited in the areas farther away, where the floodwater has little or no current.

The texture of alluvium varies widely because of differences in the material from which it was derived and the manner in which it was deposited. Alluvium soil textures found within refuge divisions range from silty, silt loams and silty clay loams (dominant associations) to loam, fine sandy loam, loamy sand, and silty clay. The soils on the river bottoms generally are underlain by sandy alluvium at varying depths.

Many of the floodplain soil associations are defined as hydric, or hydric with inclusions (of other soil types), by Natural Resources Conservation Service (NRCS). Hydric soil is defined as a soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic (no oxygen) conditions. The NRCS has mapped soils in each county and delineated each type that is hydric. Soil surveys are available through the NRCS county offices.

Mississippi River floodplain soils tend to be nearly level in nature and vary from poorly drained to well-drained. Some topographic relief is found within a few divisions, such as Louisa and Horseshoe Bend, where some loess soil may be found in the bluffs. Loess soil is wind-deposited material that consists largely of silt particles and smaller amounts of clay and sand.

Most of the soil associations mapped by NRCS have noted that they are "well-suited" or "suited" to trees, wetland habitat, or crop ground. A listing of the soils associations on the Complex can be found in Appendix J.

Water Quality

Development, agriculture, navigation, and flood control measures have all negatively impacted UMR water quality. Sedimentation is the number one management concern on the UMRS since it degrades wetlands throughout the system, diminishes diversity of water depths, and over time can convert wetlands to terrestrial habitat. Suspended sediments also increase turbidity, resulting in a reduction of light penetration that may limit or eliminate aquatic plant growth and reduce primary production by phytoplankton. Nutrients, heavy metals and pesticides also degrade the quality of wetland habitats throughout the River.

Mark Twain NWR Complex File Photo

Sedimentation

The main source of sediment filling UMRS backwaters is soil eroded from upland agricultural areas within the basin (Gaugush 1994). Average soil loss in the basin is presently about 4.4 tons/acre/year. In 1993 soil loss approached 20 tons/acre in Iowa (Lubinski and Theiling 1999). Moving downriver, the concentration of suspended materials increases and the UMR becomes more turbid as tributary streams enter the River.

Pool 19 was formed in 1913 by construction of the Keokuk, Iowa, lock and dam for hydroelectric power generation. Over 33 feet of sediment have been deposited in the lower part of the pool since the dam was completed. Pool 19 had lost about 55 percent of its original capacity by 1980. It is estimated that 80 percent of its capacity will be lost by 2050. Swan Lake on the Illinois River (Two Rivers NWR) had an approximate capacity of 4,800 acre-feet in 1902. By 1975, the capacity was reduced to about 2,800 acre-feet. While each pool has different geomorphology, the trend is the same for all pooled areas of the River.

The impacts of sediment depend, in part, on the size of the particles. Mississippi River sediment generally consists of smaller particles of sand, silt, and clay. Sand is the largest particle size and settles out of the water column the fastest, often within the main channel itself. This main channel sedimentation increases the need for dredging of the navigation channel to maintain the minimum 9-foot depth for barge traffic. In addition to the expense of dredging, environmentally suitable disposal sites are becoming increasingly difficult to find (see dredging section). Sand also tends to accumulate behind wing dams, in backwater entrances, and at the lower end of islands.

Silt remains suspended longer than larger particles and settles out in areas of lower flow, generally further down in backwaters or in quiet areas above dams. Clay, the smallest sediment particle, usually settles out in more remote backwater areas some distance from the flow of the main channel. Wind, bottom-feeding fish, and boat traffic easily stir it up. The resulting turbidity decreases light penetration, which can have severe impacts on aquatic plant growth. Fine sediments consolidate very slowly, resulting in a mucky river bottom not suitable for aquatic plant growth. All sediment types can smother mussels and other aquatic invertebrates during unusually high load events.

Developments for commercial navigation have proven costly to the River's capacity to transport sediments. By impeding its natural flow, the River's sediment transport efficiency was reduced and deposition rates increased dramatically in the impounded pools. Aquatic vegetation has declined as sediments from the uplands have accumulated in backwater areas. Navigation dams, channel training structures, levees, and channel maintenance dredging have altered river hydraulic characteristics, sediment transport processes, and the pattern of sediment deposition within the UMRS floodplain (Gaugush 1994). For the past 60 years the system has experienced high sedimentation rates but for many of those years retained good habitat. We have now begun a stage that will be marked by slower sedimentation rates, but with poorer habitat quality due to the years of accumulation without management actions to counteract this effect. Once the system reaches a sediment transport equilibrium, overall sedimentation rates may return to nearly the same levels as before European settlement (Lubinski 1992). Stabilized water levels established by dam operations also eliminated the River's annual flooding and drying pulses, which compact sediments that helped maintain highly productive floodplain habitat. The loss of depth, area, and water clarity in the backwaters has led to an overall decline in aquatic vegetation as well (Lubinski and Theiling 1999).

Both commercial and recreational boat traffic have been found to resuspend bottom sediments and to erode river shorelines. Negative effects of this erosion and resuspension include reduction of light penetration and loss of aquatic vegetation, disturbance of benthic organisms, loss of fish spawning and nursery habitat, and loss of terrestrial vegetation due to undercutting of roots.

Bhowmik (1992) conducted research on the Mississippi River and the Illinois River to determine the physical impacts of navigation, including the resuspension and lateral movement of sediment. The increase in sediment concentration was found to be higher in shallow and narrow channels (Illinois River) than in deep and wide channels (Mississippi River). Concentrations of suspended sediment increase within the wave wash zone (close to the shore) (Bhowmik 1991). Resuspension and lateral movement of sediment can have negative impacts on sensitive biological habitats, especially those bordering the navigation channels.

The impacts of recreational boating were studied in 1994 on Pool 4, near Red Wing, Minnesota (Johnson 1994). This study concluded that recreational boat-generated waves may be a more pervasive influence on shoreline erosion than commercial tows. The highest impacts were near the land/water interface and were directly responsible for elevated turbidity levels in this zone during peak boating times. Additional observations have shown an increase in shoreline erosion due to boating traffic, and sediment inflow to backwater areas might increase with increased vessel traffic (Gaugush 1994).

Isolating wetlands from the River improves the ability to control water levels and reduces the sedimentation rate. However, this isolation also can prevent inflow of nutrients, cut off important fisheries habitat, and increase flood heights downstream. To balance the need for floodplain connectivity with the need for high quality, reliable fish and wildlife habitat, spillways were constructed in the levees at Keithsburg and Clarence Cannon following the flood of 1993. The spillways allow more frequent connectivity to the River but also, presumably, a somewhat higher rate of sedimentation. The USGS has developed a plan to monitor the effects of the spillway on sedimentation and habitat at both units. Short-term and long-term changes can be monitored using the protocol.

Nutrients

Between 1945 and 1985, the application of commercial fertilizers increased 20-fold in the United States. From 1985 to 1988 the UMR accounted for 31 percent of total nitrogen delivered to the Gulf of Mexico, despite being only 15 percent of the Mississippi River Basin land area (Lubinski and Theiling 1999). Average nitrogen concentration in the River's mainstem has doubled since 1950, with commercial fertilizers being the largest source.

High levels of nitrogen input to the River begin a chain reaction. Nitrogen causes phytoplankton and algae blooms to occur sometimes so thick that growth of aquatic plants is inhibited. Decaying algae and phytoplankton consume oxygen from the water, sometimes resulting in critically low dissolved oxygen (DO) levels in parts of the UMR. A minimum of 5 parts per million (ppm) DO is necessary to maintain a healthy aquatic system. Lower DO levels often result in fish kills and also adversely affect pollution-sensitive organisms such as mayfly nymphs.

The "dead zone" in the Gulf of Mexico is an area of approximately 7,000 square miles of water (varying annually) with oxygen levels below 2 ppm. The zone lies between the Mississippi delta and the upper Texas coast and is caused by increased nutrients, such as nitrogen and phosphorus, from the Mississippi River. Changes in the distribution of fish and shrimp due to Gulf hypoxia pose a potential threat to the Gulf of Mexico's $4 billion a year seafood economy.

Other Contaminants

Other contaminants in the Mississippi River include heavy metals (such as mercury, lead, cadmium), pesticides (herbicides, insecticides, fungicides), and polychlorinated biphenyls (PCBs - an industrial chemical). Many toxic chemicals do not dissolve readily in water and adhere to small sediment particles. They may be transported downstream or settle out in backwaters and side channels. Toxic chemical discharges have decreased since the 1970s, but material discharged prior to federal regulations may still be contained in sediments (Lubinski and Theiling 1999).

Some metals (e.g. copper, zinc) are essential to living organisms but can be toxic at high concentrations, whereas others (e.g. cadmium, lead, mercury) are nonessential and toxic at relatively low concentrations. Aquatic organisms can be exposed to contaminants through contact with sediment, the water column, or the river bottom. Use of bottom sediment as spawning substrate by fish, for example, may expose sensitive young to toxic substances in the sediment. Bottom sediments in many areas of the Upper Mississippi are contaminated with cadmium, copper, chromium, lead, mercury, zinc and PCBs. Because sediment toxicity can persist for years or decades, ecological recovery or restoration efforts within the River and its backwaters may be hampered (Lubinski and Theiling 1999).

Most pesticides used in the UMR basin are herbicides used for weed control. The river basin upstream of the Missouri River contributes 40-50 percent of pesticides found in the Mississippi River, even though it represents only 22 percent of the flow from the entire basin. These chemicals enter tributary streams in both contaminated surface runoff and groundwater. The Minnesota River and the Des Moines River, for example, are the primary contributors of the herbicides alachlor, cyanizine, and metolachlor to the entire Mississippi River mainstem. Concentrations of the three major herbicides (atrazine, cyanazine, and simazine) in the Upper Mississippi River are greatest near the confluences of the Iowa, (Pool 18), Des Moines, (Pool 20), Illinois (Pool 26) and Missouri rivers (Lubinski and Theiling 1999).

Polychlorinated biphenyls (PCBs) are a class of stable industrial chemicals. Contaminants such as PCBs and methylmercury readily accumulate in aquatic organisms and can bio-magnify to high concentrations in animals near the top of the food chain. Contamination of the riverine food web with PCBs is the probable cause of the dramatic decline in mink populations on the UMR during the early 1960s. The partial recovery of mink populations that began in the late 1970s coincided with a period of declining PCB levels in fish. In 1989-91, PCB concentrations in carcasses of mink from the Upper Mississippi River in Minnesota average 0.26 ppm wet weight, exceeding concentrations in mink from all other areas of Minnesota except Lake Superior (Lubinski and Theiling 1999). Unfortunately, this indicates that PCBs are continuing to enter the food chain within the River's biological cycle. Concentrations of PCB are greatest in pools with human communities, such as the Quad Cities area, where a known point source of PCBs has contaminated Pool 15 (Lubinski and Theiling 1999).

Contaminant levels were measured in eggs collected from Black-crowned Night Herons and Little Blue Herons near East St. Louis in 1988. Herons and egrets consume aquatic invertebrates, amphibians and reptiles associated with potentially contaminated sediments. Both species showed elevated levels of the organochlorine compounds PCB and DDE (Young 1989). The rookery is near RM 174, a highly industrialized area with at least 20 hazardous waste sites within a 5-mile radius. Little Blue Herons, Cattle Egrets, Black-crowned Night Herons, Great Egrets and Snowy Egrets populated this colony. All except the Cattle Egret are recognized threatened or endangered species in Illinois. Selected reaches of the Upper Mississippi River within the AEC have formal fish consumption advisories due to high levels of organochlorine chemicals.

In 1989, staff from the Rock Island Ecological Services Office conducted contaminant studies along the Illinois and the Mississippi rivers to determine if pollutants were present in aquatic sediments. Refuge sites tested included Big Timber, Louisa, Keithsburg, Fox Island, Long Island, Delair, Batchtown, and Clarence Cannon NWR. No organic pollution from chemicals such as DDT, chlordane, or PCB was detected in refuge divisions. Heavy metal concentrations were between normal and slightly elevated. However, poor water quality conditions as indicated by low dissolved oxygen concentrations and elevated ammonia concentrations were found at Keithsburg. These findings prompted a more in-depth study to characterize water quality in the Division.

Keithsburg Division

The Keithsburg Division of Port Louisa NWR is bordered by the Edwards River to the north, Pope Creek to the south, and the Mississippi River to the west. Surface water from these streams and rivers flows into the backwater only during flood stages. Four un-named tributary ditches flow intermittently into the Refuge along the northeast edge. Subsurface water and tile effluent regularly flow into these ditches. Ground water intermittently discharges from springs in the sandy bluff along the east side of the Division.

Contaminant studies have found that water quality problems at Keithsburg limit production of desirable food for waterfowl. Many Refuge wetlands now function to treat pollution versus the functions of providing wildlife habitat and food resources. This shift in wetland functions appears to be the result of nutrient enrichment. High levels of nitrogen and phosphorus cause blooms of nuisance aquatic plants such as blue-green algae, duckweeds, and coontail, which covered a large extent of the Division at certain times of the year. These nuisance plants do not produce seeds preferred by waterfowl and do not provide substrate for invertebrate production.

The invertebrate community was poorly represented in the sloughs and was dominated by high numbers of a few pollution-tolerant species. Poor oxygen conditions, lack of plant stems, and chemical stress are the probable causes of limited invertebrate production. It is estimated that over half of the Division does not achieve its potential for annual production of desirable aquatic invertebrates.

Agricultural herbicide concentrations did not reach levels that are lethal to aquatic plants, but did reach harmful levels. The nuisance plant species apparently were not affected by the herbicide exposure, but the concern is that repeated exposure may cause the loss of sensitive species from the plant community, thereby reducing biodiversity. Wetlands that are more isolated from runoff sources contained balanced plant communities and produced a more diverse invertebrate community (Coffey 1998).

Cultural Resources – Archeology and History

As a part of this planning process the Service contracted for an archaeological and cultural values overview study of the Refuge. The resulting report, “An Archaeological and Historical Records Study for the Mark Twain National Wildlife Refuge in Illinois, Iowa and Missouri,” by Midwest Archaeological Consulting, (Rusch, McKay, Karstens) was submitted to the Service and accepted on January 7, 2000. The authors divided the study by refuge divisions to facilitate understanding and use of the report. It also included an area within a 2-mile radius outside of each division boundary. Due to the size of the study area and the rich cultural history of the Mississippi River Valley, the contract report, maps, tables, appendices, etc., total more than 600 pages. Information was provided on nearly 750 previously recorded cultural resources that are located within the Refuge Complex and the contextual study area surrounding each refuge division. Each of the sites, and associated information within one-quarter mile of the Refuge boundary have been entered into the refuge GIS system so that the information is readily available for management purposes.

The following summary is based on the overview study and other information as interpreted by the Regional Historic Preservation Officer (RHPO). With approximately 0.5 percent of the Refuge Complex having been investigated through detailed archeological survey, the current inventory of 176 known or reported cultural resources sites is thought to be a fraction of the potential sites on the Complex. Although erosion occurs at some sites, the overall trend in the river bottom is to aggrade. Deeply buried sites can be expected and are likely to be in relatively undisturbed condition. Sites and isolated resources from the Archaic, Woodland, Mississippian, and historical periods are known to exist, and many more sites likely exist. Some divisions are close to the Mississippian cultural center at Cahokia, and known Mississippian sites occupy landforms of the kind found on some divisions. In the historic period, river transportation is the single theme that connects all the divisions. In the earliest historic period, people transported materials down-river on flatboats and keel boats, and returned on keel boats or on trails paralleling the River. Landing sites, often with warehouses or stores or residences, exist throughout the length of the River. Other sites, probably not likely to be identified, would be associated with firewood stockpiling to feed the wood-burning river boats, which reportedly burned up to 10 cords of firewood a day. Land on some divisions is high enough that farming was practical. Other divisions supported camps, cabins, and resorts for hunters. Old roads, including some of historic importance in Missouri, are on or adjacent to refuge lands. Other than recent administrative and maintenance buildings, no standing structures remain on the Complex. Objectives of the overview study include identifying Indian tribes and other organizations and public groups that might have an interest in cultural resources and historic preservation on the refuge. The study identified 120 organizations and 19 Indian tribes. It also posed significant research questions to guide future archeological and other cultural resources investigation on refuge lands.

Most of the resources identified in the above described study are protected under provisions of the Archaeological Resources Protection Act of 1979 (ARPA). There have been recent developments in another important Act related to the manner historic preservation management responsibilities are conducted on the Refuge Complex and that warrant a mention in this plan. On June 17, 1999, the Advisory Council on Historic Preservation revised the rules and procedures (36 CFR 800) under Section 106 of the National Historic Preservation Act. The goal of the process is to seek ways to avoid, minimize or mitigate any adverse effects on historic properties. The Section 106 process covers any federally funded, licensed, or permitted undertaking. An undertaking is a project or activity that has the potential to cause effects on historic properties regardless of whether or not the activity ultimately results in any effect.

The responsibility of the Refuge Manager is to identify undertakings that could affect cultural or historic resources and coordinate subsequent review process with local officials. The actual determinations relating to historic and cultural resources are to be made by the RHPO for undertakings on Service fee title lands. The COE retains authority and responsibility under these acts of Congress for COE-owned General Plan (GP) lands managed as a part of the Refuge Complex, and for state-managed GP lands. Determinations relating to GP lands are the responsibility of the COE Rock Island or St. Louis Districts, as appropriate. State Historic Preservation Officers (SHPO) serve in an advisory capacity to the federal agencies and must be consulted, but the Service and COE are responsible for final decision making on federal lands.